SCIENCE EDUCATION

THE SCIENCE MAGAZINE FOR ALL SCIENCE TEACHERS
FORMERLY GENERAL SCIENCE QUARTERLY

VOLUME 16
NUMBER 3
FEBRUARY 1932

Science Education

Formerly General Science Quarterly

The Official Journal of the National Association For Research in Science Teaching

Volume 16 February, 1932 Number 3

» » Contents « «

(The Contents of Science Education are indexed in the Educational Index)

PUBLISHED BY

SCIENCE EDUCATION, INCORPORATED

The subscription price is $1.50 a year; $2.00 in Canada and other foreign countries. Single copies are 40 cents; 50 cents in foreign countries.

Prices on back numbers will be sent on request.

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For "Suggestions to Authors" concerning form of articles see the October and December, 1931, issues or write to the Editor.

PROGRAM OF THE FIFTH ANNUAL MEETING OF THE NATIONAL ASSOCIATION FOR RESEARCH IN SCIENCE TEACHING

EXECUTIVE COMMITTEE

E. R. DOWNING, *President*
F. D. CURTIS, *Vice-President*
S. R. POWERS, *Secretary-Treasurer*
W. L. EIKENBERRY
R. K. WATKINS

Saturday, February 20, 1932, 8:00 P.M. Washington, D.C.

Joint meeting with the National Society for the Study of Education and with the National Council of Supervisors of Elementary Science.

This session will be devoted to a discussion of the *Thirty-First Yearbook, Part I* of the National Society for the Study of Education, entitled "A Program for Teaching Science," prepared by the Society's Committee, S. Ralph Powers, Chairman; F. D. Curtis, Vice-Chairman; G. S. Craig, E. R. Downing, C. J. Pieper, and R. K. Watkins.

I. *The Point of View of the Yearbook Committee.*
S. Ralph Powers, Professor of Natural Sciences, Teachers College, Columbia University, New York City, and Chairman of the Society's Committee on the Teaching of Science. (18 minutes)

II. *Contributions of Research to Practices in Science Teaching.*
Francis D. Curtis, Associate Professor of Secondary Education and the Teaching of Science, University of Michigan, Ann Arbor, Michigan, and Vice-Chairman of the Society's Committee on the Teaching of Science. (18 minutes)

III. *Teaching of Physical Science in the Senior High School.*
Ralph K. Watkins, Professor of Education, University of Missouri, Columbia, Missouri.

IV. *Psychological Aspects of the Committee's Program for Science.*
Frank N. Freeman, Professor of Educational Psychology, University of Chicago, Chicago, Illinois. (15 minutes)

V. *Some Practical Aspects of the Committee's Program for Science.*
J. Cayce Morrison, Assistant Commissioner for Elementary Education, the State Department of Education, Albany, New York. (8 minutes)

VI. *The Relation of the Committee's Program for Science to the Nature Study Movement.*
E. Laurence Palmer, Professor of Rural Education, Cornell University, Ithaca, New York. (8 minutes)

VII. *General Discussion from the Floor.*
Open to Members of the National Society for the Study of Education, The National Association for Research in Science Teaching, and the National Council of Supervisors of Elementary Science. (Time limit: 3 minutes each.)

Monday, February 22, 1932, 9:30 A.M.

DR. ELLIOT R. DOWNING, *Presiding*

1. The report of the Committee of the Association on Teacher Training in the Teaching of Science. The phases of this report are (1) provisions for the education of teachers in state teachers colleges, colleges of liberal arts, and universities; (2) the content of professionalized courses; (3) state regulations in regard to certification.
   A. W. Hurd, *Chairman,* Institute of School Experimentation, Teachers College, Columbia University.
   Clarence M. Pruitt, University of Alabama.
   E. Laurence Palmer, Cornell University.
2. Discussion of Part I of the *Thirty-First Yearbook* of the National Society for the Study of Education entitled, A Program for Teaching Science. (The leaders of this discussion had no part in the preparation of the Yearbook.)
   The Recommendations for Science in the Elementary and Junior High Schools and for the Education in Science of Teachers for these Schools.
   Harry A. Carpenter, Specialist in Science, Rochester Public Schools.
   The Recommendations for Science in the Senior High School and for the Education of Senior High School Teachers of Science.
   Warren W. Knox, Supervisor of Science for the State of New York.

DINNER MEETING

Monday Evening, February 22, 1932, 6:30 P.M.

(For Members Only)

Ambassador Hotel, East Room

BUSINESS MEETING

General discussion of future policies of the Association.

Tuesday, February 23, 1932, 9:30 A.M.

DR. ELLIOT R. DOWNING, *Presiding*

1. *A Study of the Content of High School Biology.*
   Otis W. Caldwell, Teachers College, Columbia University.
2. *Analysis of Concepts in the Field of Science.*
   R. C. Bedell, Southwest High School, Kansas City.
3. *The Construction and Evaluation of Study Outlines in Physics.*
   Jessie Williams Clemensen, Los Angeles City Schools.
4. *Survey of Science Conducted by the Office of Education.*
   Wilbur L. Beauchamp, University of Chicago.
5. *The Effect of Compulsory Attendance at Semi-Weekly Oral Quizzes Upon Achievement in a Course in Human Physiology.*
   Victor H. Noll, United States Department of the Interior, Office of Education, Washington, D.C.
6. *"Objective Tests" in Science Teaching.*
   Benjamin C. Gruenberg, The Viking Press, New York City.
7. *A Laboratory Course in Visual Instruction for Prospective Teachers.*
   Morris Meister, New York Training College for Teachers, New York.

NATIONAL COUNCIL OF SUPERVISORS OF ELEMENTARY SCIENCE

Saturday, February 20, 1932 Washington, D.C.—Willard Hotel

ELLIS C. PERSING, Western Reserve University, Cleveland, Ohio, *President*
LEONA SUNDQUIST, Washington State Normal, Bellingham, Washington, *Secretary*

MORNING SESSION—9:00 A.M.

Programs in Elementary Science

9:00 *Certain Aspects of the Extension Activities of Some Institutions Designed to Assist Teachers in Elementary Science or Nature Study.*
Leo Hadsall, Graduate Student, Cornell University.

9:30 *New Laboratories of Trenton State Teachers College.*
W. L. Eikenberry and V. Crowell, Trenton State Teachers College, Trenton, New Jersey.

10:00 *Some of the Specific Objectives, Suggested Activities and Desirable Outcomes of the Revised Course in Elementary Science in Pennsylvania.*
Edward E. Wildman, Director of Science, Philadelphia, Pennsylvania.

10:30 *Launching and Maintaining an Elementary Science Program in a Large City System.*
Paul G. Edwards, Supervisor of Science, Chicago, Illinois.

11:00 *Units of Work in Elementary Science.*
R. F. Lund, Supervisor of Elementary Science, Hartford, Connecticut.

11:30 (To be announced).

12:00 Luncheon at Willard Hotel. Write to the Secretary of the Council for reservations for the luncheon.

AFTERNOON SESSION—1:00 P.M.

1:00 Annual Business Meeting of Council.

Research and Experimental Work in Elementary Science

2:00 *A Critical Examination of Tests in Junior High School Science.*
Leon Diamond, Graduate Student, Cornell University.

2:30 *Outdoor Laboratories in Elementary Science.*
Thomas Dowling, Greenville, South Carolina.

3:00 *Report of Committee on Research.*
S. Ralph Powers, Chairman, Columbia University, New York City.

3:30 *Some Observations of Science Teaching in Europe.*
G. S. Craig, Columbia University, New York City.

4:00 *The Function of a Science Teacher or Supervisor in a Progressive School.*
Rose Lammel.

EVENING SESSION—8:00 P.M.

Joint meeting with the National Society for the Study of Education.

Science Education

Volume XVI FEBRUARY, 1932 Number 3

Editorial Notes and Comments

The Washington Meetings of Science Education Associations

The fifth annual meeting of the National Association for Research in Science Teaching will be held in Washington, D.C., February 20, to February 23, 1932.

The National Council of Supervisors of Elementary Science will meet on Saturday, February 20, 1932.

Of special interest to members of these associations and to teachers of science in general will be the joint meeting of the two associations with the National Society for the Study of Education on the evening of February 20, 1932. At this meeting there will be presented the *Thirty-First Yearbook, Part I,* of the National Society for the Study of Education, entitled "A Program for Teaching Science."

The programs of these meetings will be found on previous pages of this issue.

A Program for Teaching Science

The *Thirty-First Yearbook, Part I,* of the National Society for the Study of Science Education, which is being published this month, is entitled "A Program for Teaching Science." The Yearbook has been prepared by a committee selected by the National Society for the Study of Education. This committee is composed of the following members: Gerald S. Craig, Francis D. Curtis (Vice-Chairman), Elliot R. Downing, Charles J. Pieper, S. Ralph Powers (Chairman), and Ralph K. Watkins.

This committee has been assisted by the following active members of the National Society for the Study of Education: Florence G. Billig Frank N. Freeman, Lillian Hethershaw, Morris Meister, J. Cayce Morrison, Victor H. Noll, and E. Laurence Palmer.

Based upon modern principles of education and upon the results of investigations in the field of science education the report of the committee presents the place and purpose of science in public-school education and proposes definite methods for accomplishing an integrated curriculum of science instruction from the first grade through the twelfth grade. Definite suggestions are offered for programs in Grades I to VI, in grades VII to IX and in the special sciences for grades X to XII.

The report promises to be of such significance to the future of science teaching in the American Public Schools that chapter titles are here given to acquaint our readers with the nature of the report:

I. The Plan of the Public Schools and the Program of Science Teaching
II. Some Criticisms of Current Practices in the Teaching of Science in Elementary and Secondary Schools
III. What are the Contributions of Science to Liberal Education?
IV. The Objectives of Science Teaching in Relation to the Aim of Education
V. Psychology of Science Teaching
VI. Some Contributions of Educational Research to the Solution of Teaching Problems in the Science Classroom
VII. Some Contributions of Educational Research to the Solution of Teaching Problems in the Science Laboratory
VIII. Investigations Relating to the Content of Science Courses
IX. Curricular Developments in the Teaching of Science
X. The Program of Science in the Elementary School
XI. The Technique of Analysis to Determine Content in Science for the Elementary School
XII. Suggested Content for the Grades of the Elementary School
XIII. Science in Grades Seven, Eight and Nine
XIV. The Course of Study in Biology
XV. Instruction in Physical Science in the Secondary Schools
XVI. Science Rooms and Their Equipment
XVII. Science Teaching on the College Level
XVIII. Programs for the Education of Science Teachers in State Teachers Colleges

The Yearbook closes with a section prepared by a special reviewing committee. In this section the report of the Yearbook Committee is evaluated from the point of view of its psychological and practical aspects.

Readers of Science Education are invited to send to the editor such comments or criticisms as occur to them upon the reading of the Yearbook. If the number and character of these comments warrant, we shall include them in a later issue as a symposium on "A Program for Teaching Science." Communications may relate to the program as a whole or to any section of the yearbook.

References in Science for Laymen, Students, and Teachers

In the December issue we brought to the attention of our readers a series of book lists recently issued by the Enoch Pratt Free Library in collaboration with the American Association for the Advancement of Science.

These lists appear to us to be of such value and the procedure by which they have been prepared is of such character that we quote from a letter, dated December 19, 1931, and sent by the American Association for the Advancement of Science to public librarians, college librarians, and museum directors throughout the country:

> For over two years, a committee of the American Association for the Advancement of Science has been preparing a series of twenty-seven science booklists. More than 2,000 promising titles have been carefully considered. Two preliminary mimeographed lists of selected titles for each list were sent to specialists in various sections of the country for votes and comments, and the resulting titles are, it is felt, thoroughly worthy of recommending to the public.
>
> The intention of this Committee was to publish a series of attractive lists of worthwhile books, which are neither too ephemeral in their attempt to be popular, nor too heavy to appeal to the "out-of-classroom" student of each of these subjects.
>
> The funds for printing these lists have been provided by the Carnegie Corporation of New York.
>
> They are to be distributed free, within certain limitations, through public libraries to their communities at large, through college libraries to members of the classes in various science subjects, and through museums to their thousands of visitors, many of whom become interested in worthwhile study. Public libraries by cooperating with high school libraries, will be able to place these lists in the hands of many upper-class students who follow scientific hobbies outside of school hours.
>
> Kindly examine these lists with care, and let us know, on the enclosed schedules, how many copies of each list you can distribute to advantage; by "advantage," we mean getting them into the hands of promising individuals who will, so far as one can predict, be likely to do some worthwhile reading. It is hoped that there will be no waste in the distribution; it is not the intention that they should be allowed to accumulate at library loan desks, in the offices of faculty members, or in the storerooms of various institutions. It is assumed that the gift of a reasonable number of copies of these lists will carry with it the obligation to have them distributed with discrimination, within the next three or four months.
>
> In returning the enclosed schedule of requests the Committee will expect to find that some lists are asked in greater number than others, according to the probable demand in each community. The edition of the various lists will be based on these returns, and the total number of copies given to any public library will depend on the population of the community, in the case of college libraries, on the number of students in the college, and in the case of museums, on the annual number of visitors.
>
> Please note that beyond this first free distribution of copies, the Committee will be able to supply additional copies of each list only on the payment of cost, which will be at the rate of one cent per list in any quantity, and in any assortment. This is a special price made to libraries and institutions. As is stated on nearly all the lists, individuals who wish to secure complete sets of the lists can do so personally by sending 30 cents in stamps direct to the Association office at Washington.

We trust that in this far-reaching project of encouraging the reading of worthwhile books on modern science, your institution will take an active part.

Very truly yours,

Dr. Paul R. Heyl, Physicist, U. S. Bureau of Standards, Washington, D.C.
Dr. Edward W. Berry, Dean, Johns Hopkins University, Baltimore, Md.
Dr. Burton E. Livingston, Professor of Plant Physiology and Forest Ecology, Johns Hopkins University, Baltimore, Md.
Mr. Joseph L. Wheeler, *Chairman;* Enoch Pratt Free Library, Baltimore, Md.

The schedule of requests for the science book lists referred to in the letter quoted, contains the names of lists now available. The titles of these lists follow:

Science in the World Today; The History of Science; Exploring for Science; Mathematics for the Layman; Wonders of the Sky; The Earth and its Wonders; The Wind and the Weather; Modern Physics; Chemistry of Today; Microbes and the Microscope; Biology, the Science of Life; Plants and Their Ways; Wild Flowers—How to Know Them; The Ferns, Mosses and Fungi; Our Trees and Shrubs; Zoölogy—The Science of Animal Life; Our Friends the Animals; Our Friends the Birds; Entomology—The Wonders of Insect Life; The Sea and the Shore; The Life of Inland Waters; Fishes, Frogs and Reptiles; Fossils and Their Story; Evolution and Heredity; The Making of Man; The Teaching of Science.

The last-named book list has been printed in the form of a tentative edition. It is our understanding that this list is being revised and will appear in permanent form in the near future.

Those interested in the preparation of these lists may find a more complete account in *Library Journal,* December 15, 1931.

Summary and Bibliography of Investigations Relating to the Psychology of the School Subjects

The December, 1931, issue of the *Review of Educational Research,* published by the American Research Association, is devoted to summaries of the investigations relating to the psychology of reading, handwriting, spelling, English languages, arithmetic, social sciences, mathematics, foreign languages, science education, commercial subjects, industrial arts, fine arts, music and health. Each chapter has been prepared by a specialist in his field.

It would appear from an examination of the summaries and bibliographies in the various subjects that the authors hold quite divergent views on what constitutes a research study in the psychology of a school subject. As stated in the preface, "From a broad point of view studies in the objectives of the curriculum, studies in method, or studies in methods of testing may be considered as psychological in nature." Several authors have undoubtedly taken this broad point of view. Others have limited the sum-

maries to studies which represent analyses of the learning process and of the elements of learning involved in the particular subject. The content of the issue is, therefore, another illustration of the fact that the title of a monograph does not always indicate the nature of the content.

Our readers will be interested in the summary of studies presented in the chapter on "Science Education" by S. Ralph Powers and in the bibliography which accompanies this chapter. From our point of view, it is disappointing to believe that the small space given to this subject did not make it possible to present a more searching analysis of the methods and results of studies relating to the psychology of science teaching.

As one reads this summary and scans the titles of studies in the bibliography it is apparent that relatively few studies in the field of science education have extended research to the more fundamental questions concerning the nature of science and concerning the elements and processes of learning in this subject. There is, for those trained in psychology and in the fundamental sciences, an appealing and almost unlimited field for further research at these deeper and more basic levels. This kind of research, moreover, is essential to a valid interpretation and evaluation of the results of the more superficial studies relating to objectives, teaching techniques, and measurement of results in science teaching.

An Investigation to Determine the Relative Effectiveness of Two Methods of Teaching Elementary Science in the Fifth Grade*

MARTIN L. ROBERTSON
University High School, University of Michigan

Purpose

The purpose of this investigation is to compare the relative effectiveness of a "study-guide" and a "developmental discussion" method of teaching elementary science in the fifth grade with respect to both immediate and delayed recall.

This study is specifically limited to the two experimental factors named. It is not concerned with the grade level of content, order of arrangement, order of presentation of topics, or with the relative values of the various subject matter elements.

Method

Two kinds of material were deemed suitable for presentation to this fifth grade: (a) topics relating to phenomena that occurred in the immediate environment of the children and (b) topics relating to phenomena easily demonstrated by simple classroom experiment. On this basis six units selected from Craig's[1] material were considered to be suitable for instruction by both methods. The units selected related to the causes of the phases of the moon, ice formation, magnetism, the migration of animals, the hibernation of animals, and the change in form and appearance of animals and insects.

The form of these units was considered suitable for the developmental discussion method as written by Craig. It was necessary, however, to adapt them to the "study-guide" method by rewriting the subject matter into a unit story to serve as a textbook. These unit stories were critically examined by the English teachers of the fifth grade and were later revised in the light of these criticisms. The stories were occasionally illustrated with diagrammatic line drawings. A guidance outline over the subject matter of the unit story was provided as an aid to study.

With each method the teacher introduced the unit topic orally. In the "study-guide" method the class interest was then motivated by exploratory questions. After the specific aims of the unit had been developed as

* Reported before the National Council of Supervisors of Elementary Science at Detroit, Michigan, February 21, 1931.

TABLE I

RESULTS OF PAIRING THE GROUPS ON THE BASIS OF READING ABILITY*

Unit	Group	Number of Pupils	Mean Grade Level of Reading Ability	S.D.	$\frac{M_1-M_2}{SDD_M}$†
I	B	19	5.43	1.61	−.28
	A	33	5.54	1.33	
II	B	22	5.44	1.55	−.36
	A	26	5.60	1.38	
III	B	22	5.52	1.25	.000
	A	33	5.52	1.30	
IV	B	21	5.54	1.66	.000
	A	29	5.54	1.28	
V	B	12	5.63	1.63	.27
	A	18	5.48	1.26	
VI	B	19	5.38	1.65	−.63
	A	19	5.68	1.34	

* The groups were considered to be equivalent when the difference of their means divided by the standard deviation of the difference of their means was less than one.

† The standard deviation of the differences of the means was computed from the following partial formula:[4]

$$SDD_M=\sqrt{\left(\frac{SD_1}{\sqrt{N_1}}\right)^2+\left(\frac{SD_2}{\sqrt{N_2}}\right)^2}$$

problems during the exploratory period, the mimeographed textbook material, with its guidance outline for study attached, was distributed. The children proceeded to assimilate the material while the instructor moved about among them to assist them by clarifying the text whenever necessary. At the close of each class period these texts were collected by the instructor. At the close of the assimilation period each child made a brief topical outline of the material of the unit on the back of his study sheet.

In the "developmental-discussion" method the class interest was again motivated by exploratory questions and the specific aims of the unit were

TABLE II

RESULTS OF PAIRING THE GROUPS ON THE BASIS OF INITIAL INFORMATION

Unit	Group	Number of Pupils	Mean of the Initial Test	S.D.	$\frac{M_1-M_2}{SDD_M}$
I	B	19	9.95	3.78	.03
	A	33	9.91	3.00	
II	B	22	9.45	2.27	.49
	A	26	9.11	2.52	
III	B	22	13.04	5.03	−.51
	A	33	14.00	4.26	
IV	B	21	7.33	2.30	−.86
	A	29	7.93	2.58	
V	B	12	9.08	4.01	−.55
	A	18	9.89	4.00	
VI	B	19	9.59	3.56	−.42
	A	19	9.21	1.67	

developed as problems during this period. The instructor by careful questioning then drew the subject matter from the children's experience. It was sometimes necessary for the instructor to contribute material to the discussion to insure that the material covered was the same as that covered by the written unit-story. After the period of discussion the conclusions were made by the class and written on the board by the instructor.

The tests used in this investigation were objective and were composed of about thirty items per unit. These items included matching, completion, and modified true-false types.[2] The whole group of tests, consisting of one hundred eighty items, was administered at the beginning of the investigation. Each unit test was given at the close of the period of instruction to test immediate recall. The entire initial test was again administered at the close of the investigation for the purpose of measuring retention.

In this investigation sixty fifth-grade students in the Oxford School of District Number Seven, Dearborn, Michigan, were used. Due to irregularities in attendance, it was deemed advisable to equate the groups separately for each of the six units of instruction and again at the close of the

TABLE III

COMPARISON OF THE RESULTS WITH RESPECT TO KNOWLEDGE OF SUBJECT MATTER AT THE CLOSE OF THE PERIOD OF INSTRUCTION*

Unit	Group	Number of Pupils	Mean Change	S.D.	$\frac{M_1-M_2}{SDD_M}$	E.F.
I	B	19	9.37	3.22	.97	D.D.
	A	33	8.45	3.30		
II	B	22	1.77	2.02	−4.78	D.D.
	A	26	5.54	3.35		
III	B	22	4.18	5.14	−.94	D.D.
	A	33	4.30	3.93		
IV	B	21	8.19	3.92	2.04	D.D.
	A	29	6.00	3.49		
V	B	12	10.42	4.29	−.99	D.D.
	A	18	11.67	3.73		
VI	B	19	9.16	4.02	.63	D.D.
	A	19	8.36	3.67		

* Units I, IV, and VI were presented to group B by the "developmental-discussion" method. Units II, III, and V were presented by the "study-guide" method. In this table as well as in Table IV the data for group B are written first. This accounts for the negative results in Units II, III, and V.

investigation. The groups were equated by securing the average of the scores made on seven units of the Sangren-Woody Reading Test[3] and on the basis of their previous science achievement as determined by their reaction to the initial test over the six units.

Tables I and II show the degree of equivalence secured by the two bases of pairing.

The investigation was continued for fourteen weeks; each group devoted two twenty-minute periods a week to the study of science.

The following factors were kept identical for both groups, which met during consecutive afternoon periods: (1) the teacher, (2) the length of period, (3) the items of subject matter, and (4) the date upon which a specific unit of instruction was presented. Care was taken to insure that

the items covered in the initial test were all included in the units of instruction.

The rotation method of experimentation was used in accordance with which each group studied successive units by each method in turn. Each

Table IV

A Comparison of the Relative Efficiency of Two Methods of Teaching Science as Indicated by a Delayed Test

Unit	Group	Number of Pupils	Mean Change	S. D.	$\frac{M_1-M_2}{SDD_M}$	E. F.
I	B	19	9.00	3.74	.30	D.D.
	A	33	8.70	3.22		
II	B	21	2.24	2.18	−3.90	D.D.
	A	26	5. 5	2.83		
III	B	22	5.68	5.82	.69	G.O.
	A	33	4.67	4.33		
IV	B	21	6.81	3.62	1.02	D.D.
	A	28	5.75	4.34		
V	B	12	12.33	3.64	−.29	D.D.
	A	18	12.72	3.54		
VI	B	19	9.58	3.56	.35	D.D.
	A	19	9.21	2.86		

class was taught three units under each method. The method was so rotated that the same unit of subject matter was presented on the same day under the two experimental factors. The effectiveness of teaching by each method was determined for each unit, both for immediate recall and retention, by averaging the gain on the unit test of the group using that method. The significance of the results was determined by dividing the difference of the means by the S. D. of the difference of the means.[5]

Findings

It will be noted in Table III that such advantages as were revealed by the test of immediate recall were without exception in favor of the "developmental-discussion" method. However, except in Unit II, these results are

not statistically significant since the quotient obtained by dividing the difference in means was less than three.[5] In comparing Table IV with Table III one notices that with respect to delayed recall, with the exception of Unit III, the "developmental-discussion" method still appears to be somewhat more effective. In three cases the results are less significant than in Table III, in two cases they are more significant, and in one case they are reversed.

Conclusions

1. It is apparent that the subject matter materials used in this investigation were entirely practical for use with these fifth-grade pupils by either method.

2. In so far as the results of this investigation may be accepted, it seems reasonable to conclude that this "developmental-discussion" method has some slight advantage over this "study-guide" method both with respect to immediate recall and retention, though the results as a whole are not statistically significant.

3. The data of this experiment would seem to indicate that the results secured by the "study-guide" method at this grade level do not justify the great amount of work required to reorganize the course.

Implications

This "study-guide" method requires the preparation of guides and often texts, thereby increasing the teacher's load without seemingly increasing the efficiency of instruction, if the results of this investigation may be considered indicative. It must be remembered, however, that this "study-guide" method gives valuable training, which this "developmental-discussion" method does not afford, in study habits and in organization not measured by these tests. On the other hand, this "developmental-discussion" method gives training in oral discussion and in the various phases of socialization which the other does not afford. It is the writer's hope that further investigations distributed over a longer period of time and utilizing greater numbers of pupils will follow. Until that time, this investigation may be of value to those teachers now contemplating a change of teaching technique.

REFERENCES CITED

[1] CRAIG, GERALD S., *Tentative Course of Study in Elementary Science*. New York: Bureau of Publications, Teachers College, Columbia University, 1927.

[2] MCCLUSKEY, HOWARD Y., and CURTIS, FRANCIS D. "A Modified Form of the True-False Test," *Journal of Educational Research* 14:213-214.

[3] SANGREN-WOODY, *Reading Test*, Form A. New York: World Book Company, 1927.

[4] GARRETT, HENRY E. *Statistics in Psychology and Education*. New York: Longmans, Green and Company, 1926. p. 133.

[5] Ibid. p. 133.

Activity Analysis as a Basis for Supervision in General Science

Edith M. Selberg
Colorado State Teachers College, Greeley, Colorado

It is of primary importance that the supervision of the teaching process should be based upon a sound philosophy of education. The philosophy of Dewey and others, namely, that *education is growth,* is accepted by the writer to be the all inclusive objective of education. This philosophy, according to the writer, should be the basis for the selection, the organization, and the technique of teaching in both professional and academic courses. If this point of view is accepted it necessarily means that the task of any supervisor is to point out the essential elements of teaching which will make for growth in the teacher. Specifically, it is the work of the supervisor in a training-school situation to make the pre-service teacher cognizant of the elements of good teaching which are essential for future development and growth. In addition to this, it is the business of the supervisor to assist the student-teacher in clarifying the theories and principles learned in other professional classes. The degree to which a teacher will progress and grow depends upon how intelligently he performs these activities. It is, therefore, the essential duty of the supervisor to help the beginning teacher make the transition from theory to practice and to make the theory meaningful. A student may learn a concept in the theory class but it is quite another thing to recognize and apply that concept in a practical situation.

Secondly, it is important that the supervisor be able to recognize the typical errors and difficulties of beginning teachers and the causes for the difficulties. Just as a diagnostic study of pupils' reading and study habits are essential for guiding the learning processes of pupils, so a diagnostic study of student-teacher errors and difficulties will be helpful to the supervisor in guiding the beginning teacher.

Purpose of Investigation

The purpose of this study was to analyze the student-teacher activities of twenty-one student teachers in two general science classes in order to discover: (1) the common errors made by beginning teachers in science, (2) the more difficult elements of teaching in general science, and (3) the reasons why certain teaching activities were difficult.

Technique

The supervisor recorded the errors made by the student teacher during the actual classroom teaching. The student-teacher was asked to tabulate all the activities actually engaged in for a period of two weeks, such as grading papers, planning demonstration lessons, planning a test, and many others. Then, through a personal interview with the student-teacher, the supervisor was able to learn and record a reason why certain activities were more difficult than others. Through an analysis and comparison of the data thus obtained, ideas were arrived at as to the relative degree of difficulty of the various teaching activities and as to the amount of attention and emphasis which should be given to each.

Findings

The findings of this study are based upon the opinions of twenty-one student-teachers of general science and their supervisor in the Training School of Colorado State Teachers College.

Table I shows the frequent errors made by the student-teachers. The word *frequent* means that these errors occurred at least twenty-five or more times during the quarter-term of teaching.

From a study of Table I and the personal interviews with the student-teachers, the following generalizations were made:

1. Certain teaching activities are very difficult for beginning teachers and require careful attention in the supervisory program;

2. Some of the activities especially difficult, as revealed by personal interviews, and some of the reasons for each difficulty, as stated by students, are:

a. *The preparation of the daily lesson.* "It is difficult to pick out the essential points." "It is difficult to put the subject matter across to pupils." "Questions are hard to formulate." "It is hard to provide for individual differences." "My background for the unit was weak." "It is difficult to form drill questions." "I'm not sure of the technique until I try it." "I must use my own judgment and I'm not sure I am correct." "Individual study helps are hard to devise."

b. *Questioning.* "It requires ability to ask reflective rather than recall questions." "It is hard to ask questions which will stimulate thinking."

c. *Conducting the lesson.* "Hard for me to think on my feet." "Hard for me to talk to a group." "Hard for me to make up my mind quickly when problems arise." "This method of teaching requires a good background of science." "It is difficult to supervise so many pupil activities which is necessary under the individual instruction plan."

d. *Making assignments.* "It requires ability to give definite directions." "It requires ability to teach pupils how to study." "It requires ability to foresee the difficulties of the student."

e. *Preparation of tests.* "It is difficult to determine questions that test all degrees of ability." "It is difficult to determine the right concepts to be tested." "Hard to determine the right kind of tests." "Hard to make a test that will adequately determine the ability of all students of the class."

TABLE I

ANALYSIS OF ERRORS AND DIFFICULTIES OF BEGINNING TEACHERS IN GENERAL SCIENCE

No.	Errors in Schoolroom Mechanics
1.	Fails to regulate light and ventilation
2.	Fails to use time-saving devices in distributing materials
3.	Does not provide time to put away materials
4.	Fails to have proper equipment ready for use
5.	Disregards his own posture
6.	Lack of order in passing from room to room
7.	Fails to quiet pupils upon entering the room
	Errors in Recitation and Directed Study
8.	Too much teacher activity
9.	Fails to apply the scientific principles to a practical situation
10.	Fails to drill on scientific words and phrases
11.	Assignments inadequate due to incompleteness and indefiniteness
12.	Directions poorly given
13.	Answers questions that pupils can answer
14.	Questions not worded clearly and concisely
15.	Questions do not focus upon the principles of the unit
16.	Fails to emphasize the elements of problem solving
17.	Students not made to evaluate own statements
18.	Does not insist upon reasonably good English
19.	Pupil's voice audible to teacher only
20.	Teacher's voice indistinct
21.	Lack of illustrations to clarify principles
22.	Fails to see that language is confusing to the class
23.	Fails to ask questions which require reflective thinking
24.	Fails to use blackboard to good advantage
25.	Fails to provide supplementary material
26.	Fails to locate pupils' errors in solving problems
27.	Fails to stimulate disinterested student
28.	Fails to provide for individual differences
29.	Fails to guide pupils in the analysis of problems
	Errors in Testing
30.	Fails to select important concepts for testing
31.	Fails to test for the elements of problem solving
32.	Statements ambiguous

f. *Giving demonstrations.* "It is hard to determine how the application is to be made." "It is hard to determine the type of demonstration for the type of subject matter." "It is hard to determine the questions which will set up a hypothesis in the student's mind."

g. *Determining grades.* "It is difficult to keep the subjective element out of grading." "Uncertain as to best method of grading." "I felt that students should have better grades."

The answers or reasons stated above are worthy of consideration on the part of the supervisor. If they are carefully studied, it may be readily seen that the activities are intrinsically difficult. A recognition of these difficulties should develop an appreciative and sympathetic attitude on the part of the supervisor for the beginning teacher.

If the *reasons* for teaching difficulties are compared with the *frequent errors* made in teaching as shown in Table I, it is found that one accompanies the other. The hardest tasks are the ones in which frequent errors are made.

3. Some of the frequent errors arise because the young teacher does not understand or is unable to apply certain pedagogical principles and theories, such as:

a. that the elements of problem solving must be emphasized in every phase of science teaching;
b. that a scientific principle or generalization is not learned until the pupil can apply it to a practical situation;
c. that students should evaluate their own statements;
d. that the *skill* to be developed in science is reflective thinking;
e. that through individualized instruction pupils learn correct study habits, learn to solve individual problems, and proceed to learn at a rate which is equal to their ability.

4. These considerations indicate the importance, to the supervisor, of a careful analysis of student-teacher difficulties. They also suggest that by careful attention to the elements involved in each activity, the beginning teacher can be guided in a more satisfactory manner.

Conclusions

1. A knowledge of the common errors in student-teaching is essential to properly guide the beginning teacher for development and growth.

2. Many of the common errors made by student-teachers in general science are connected with the more difficult activities in teaching.

3. Student-teachers find it difficult to apply the pedagogical theories and principles in the actual teaching of the schoolroom.

4. The student-teacher should be given adequate drill and practice in recognizing and applying the elements involved in the activities suggested in Table I.

5. A diagnostic study of beginning-teacher errors and difficulties is valuable in that it modifies and clarifies the supervisory technique.

Talking Pictures for Teaching Purposes

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Science, more than any other branch of the curriculum, has pioneered in visual instruction methods and especially in the use of motion pictures. Another element was introduced some five years ago—the talking picture. This element has just emerged from the unformed period of commercial development and is now ready for educational use. Subjects intended primarily for teaching purposes are being rapidly produced by various concerns, and progressive departments of science are looking forward to being able to take advantage of this opportunity for more effective and thorough teaching.

The purpose of this article is to discuss the equipment necessary and to give such practical advice as has been the result of more than a year's operation of talking pictures in public schools. During the last few months, advertisements of various types of talking picture equipment have been appearing in journals of the teaching profession. While all of these devices possess some merit, certain ones are better adapted than others to specific requirements, and it is difficult for one who has not had facilities for careful investigation to choose properly according to his needs.

For those who have more mechanical ability than funds, the construction of an outfit utilizing present equipment will be the best procedure. Others can obtain from various sources the several units, assembling the whole with little difficulty. If expense is not to be considered, a complete outfit may be purchased, with consequent saving in labor, even though there probably will be no gain in quality of results. The most practical system of talking pictures for classroom teaching purposes utilizes the 16 mm. film with sound-on-disc. This system is identical with the commercial Vitaphone except in the use of the smaller film.

A talking picture installation is not at all the complicated, difficultly-understood mechanism it is sometimes thought to be. Using sound-on-disc, the various units are the projector, a synchronized turntable, an electrical sound amplifier, a speaker, and the usual motion picture screen. These units are discussed in order below, primarily from the standpoint of one desiring to assemble his own outfit.

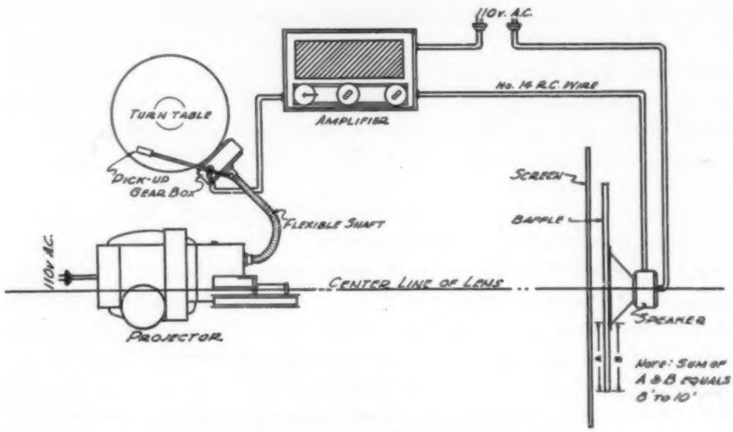

FIGURE I. A 16 mm. Talking Picture Outfit
(Not drawn to scale)

The Projector

It is essential that the 16 mm. projector be sturdily constructed and that the motor be strong. The Bell and Howell Filmo can be unqualifiedly recommended, as can the Victor and Ampro projectors. If any one of these three machines is already in the school, a principal part of the outfit is at hand.

The projector must be capable of running at the standard talking-picture-film speed of 24 frames per second—50 per cent faster than the silent-standard-film speed of 16 frames per second—, at the same time driving the synchronized turntable. If the film-handling mechanism of the projector is capable of this excess speed, but the motor will not supply enough power because of low voltage of the city power supply, the difficulty can be eliminated by means of a step-up transformer described later.

The Synchronized Turntable

The essential principle of the sound-on-disc system is that if the film and record are driven by the same motor and are started together, they are certain always to be in step. Two methods are used to connect the turntable to the projector: the more common one is a flexible shaft connected to a suitable moving part of the projector at one end and attached at the other end to a train of gears driving the record turntable; the other method, a feature of the Victor machine, consists in mounting the record turntable vertically on a rigid shaft projecting from the side of the machine.

Except with the Victor machine, the flexible-shaft method must be employed. A flexible-shaft turntable with which we have had satisfactory results is the Cine-Voice, which sells at a very reasonable price, and which may be attached successfully to any of the projectors named above. Those who do not already possess a suitable 16 mm. projector should, in selecting a projector, consider the Victor machine consisting of projector and turntable built into a single unit.

The standard playing speed for all sound recordings, excepting ordinary phonograph records, is 33⅓ revolutions per minute. If the projector which drives the turntable runs faster or slower than 24 frames of film per second, the record will turn faster or slower than 33⅓ r.p.m. and the sound will not be natural. The projector may be adjusted to proper speed either by ear until the voices sound natural or by a stroboscopic device, such as that supplied on the Bell and Howell Filmophone.

In selecting a turntable, one should be chosen heavy enough to assure steadiness in rotation and of approximately the same size as the records, which are sixteen inches in diameter. It is believed that any attempt to adapt a standard phonograph turntable for this purpose will not be successful. The turntable unit will include the electrical pick-up that converts the mechanical vibrations from the record into electrical vibrations which are fed into the input of the amplifier.

The Amplifier

From the bewildering array of amplifiers now on the market, we have chosen as most suitable for the average small outfit the Loftin-White type. This amplifier combines the desirable qualities of simplicity, compactness, and inexpensiveness with excellent tone quality and ample power. It can only be used, as a rule, with a city power supply of 105 to 120 volts and 50 to 60 cycles. A model using a single "250" power tube in the last stage will probably be most satisfactory. This type of amplifier may be obtained at very low price from any of the radio bargain houses. While an installation with this amplifier is a very simple matter, those unfamiliar with such electrical work should consult the best local radio specialist.

If the school possesses a very good modern radio, it may be used as the amplifier and speaker by running a pair of wires from the pick-up of the turntable to the phonograph jack at the back of the radio. If the radio does not already possess such a jack, one can easily be installed by a competent radio service man. The line running from the pick-up to the radio should be as short as possible and should be of number 14 copper wire to reduce electrical resistance.

We believe, however, that the use of a special amplifier, rather than such an adaptation of a radio, will invariably give better results.

The Screen

The ideal screen for talking pictures is a beaded porous "sound screen" of a type of which the Vocalite is an outstanding example. Such a screen is extremely brilliant and permits placing the speaker behind it without obstructing the sound waves. Unfortunately, however, the expensiveness of a glass-bead sound screen often prohibits its use. The best alternative is a piece of sheetrock fastened to a solid wooden frame, mounted more or less permanently. The screen surface must be sprayed on, since it is practically impossible to produce an even finish with a brush; silver Duco should be used. The work is best done by a licensed Duco automobile refinisher, the workman being instructed to avoid a glossy, mirror effect and to secure instead a matte, dead-white appearance. The slightly rough texture of the sheetrock will aid greatly in obtaining a satisfactory screen surface.

The screen should be as large as practicable, even up to six by eight feet. Miniature characters on a tiny screen always seem ludicrous in a talking picture. With a large image it is necessary to use either a glass bead or a silver screen in order to obtain sufficient illumination.

The Speaker

There are two principal types of cone speakers, magnetic and dynamic. Only the latter type should be considered. There are two classes of dynamic speakers, called A.C. and D.C.; these designations refer to the kind of current that must be supplied to excite the field of the speaker. If the amplifier is designed to supply the proper field current for the speaker, the less expensive D.C. type may be used; in this case there will be two pairs of wires running from the amplifier to the speaker: one pair from the "Output" of the amplifier to the voice coil or "Input" of the speaker, and another pair from the "Speaker" or "Field" terminals of the amplifier to the "Field" of the speaker—these connections must not be interchanged. If the amplifier is not designed to supply the proper field excitation current, an A.C. speaker must be used, for which the necessary field current is supplied from any light socket carrying 110 volts at 60 cycles.

After dismaying the non-technical reader with the above particulars, let us hasten to assure him that the subject will, upon acquaintance, prove to be much less complex than it may now seem.

Regardless of the type of cone speaker used, it must be well baffled in order to get the proper tone quality. The least expensive and most effective

type of baffling consists of two thicknesses of celotex made rigid with wooden framing, with the speaker fastened behind a hole in the center. This hole should be of a diameter slightly smaller than that of the speaker cone, and the speaker should be bolted snugly in place so that no air may leak between the edge of the speaker and the edge of the baffle hole. The baffle should not be less than four feet square; if the installation is permanent, the baffle may well be as large as six by eight feet—the more baffling the better. In order to save space, most speakers are inadequately baffled; best reproduction of low notes can only be secured when the distance from the front surface of the speaker cone to its rear surface, around the edge of the baffle, is eight to ten feet. These requirements may seem unnecessarily exacting, but they are imperative if good speech quality and low notes are to be retained.

The Position

The position of the speaker has a great deal to do with the realism of the talking picture. The ideal position is behind the center of the screen, but this position is only practicable with a special "sound screen" which does not muffle the sound from the speaker. With any other type of screen, the cone of the speaker should be just below the edge of the screen, the upper part of the baffle rising behind the screen. Only those very near will be able to tell that the sound does not come from the lips of the character speaking.

In addition to what has already been said concerning the attainment of good tone quality, we strongly advise the purchase of the best speaker that can be afforded, especially one of the "auditorium" or "concert" dynamic types. Purchasing the speaker, as well as the amplifier, from a radio bargain house will save money.

Operating Hints

As we have stated before, if the film and the record are in synchronization when they are started, they will automatically remain so throughout the entire reel if the film has not been damaged. To start "in sync," the frame of film marked "start," or scratched "x," must be threaded into the projector so that it lies over the light aperture. The record should then be laid on the turntable, the point of the pick-up needle placed in the innermost groove of the record opposite the starting arrow, and the clamping nut screwed down to hold the record firmly in place. The projector should be started without using its clutch, so that it may gain speed slowly and without jerking.

It is easy to ascertain that all electrical connections have been properly

made and that the amplifier is operating by rubbing the point of the pick-up needle with the finger; a dull, rasping noise should be heard in the speaker. With steel needles, a new one must be used for each record; with chromium needles, a dozen or so records may be safely played.

If, through incorrect starting, the sound does not coincide exactly with the action, either the machine should be stopped and the reel re-started or the following operation attempted. While the machine is running, carefully loosen the record clamping nut; preferably during a moment of silence, grasp the edge of the record and shift it ahead or retard it slightly, according to the direction in which it is "out of sync."

If there is difficulty in keeping the projector up to the necessary speed because of low voltage of the city power supply, a step-up transformer can be made to produce the necessary output voltage with any one of a series of input voltages. As a matter of fact, if the city power supply is less than 120 volts such a step-up transformer will almost certainly be needed. We have found that 125 to 130 volts gives ample power and steadier speed; with this voltage the projection bulb is burned at about a ten per cent overload, probably decreasing its life slightly but securing a whiter and almost doubly brilliant light in compensation.

If the electrical disturbance created by the running projector motor is heard in the speaker, the noise can be eliminated by connecting a wire to some metal part of the turntable and grounding the other end to a water pipe. If there is a "ground" post on the amplifier, it should be connected to the water pipe also.

A good film will rarely break if the projector is in proper working order and the film gate kept clean. If such an accident should occur, extreme care should be taken to replace with black film the same number of frames as have been removed. If this precaution is neglected, the rest of the film following the splice will always be out of synchronization.

Securing Films

Many companies are just beginning the production of 16 mm. talking pictures for teaching purposes, and most of the subjects produced thus far are scientific in nature. Films may be bought, rented, or obtained free, generally in excellent condition. The rental price for a film and the accompanying record varies between two and four dollars per reel per day used. A copy of *Directory of 16 MM Film Sources* should be secured from the Victor Animatograph Company, Davenport, Iowa, along with their latest list of sound films.

If school funds are not sufficient to completely finance talking picture

rentals, it has been our experience that students are always interested and willing to pay a nominal sum to help defray such expenses.

The above material does not in any way pretend to be a detailed set of instructions on how to construct a talking picture outfit. It is, rather, a set of general principles derived from successful use of talking pictures in science instruction in the Austin schools. The results we have obtained support in every respect the findings of the tests conducted at Washington* during the past summer. In addition to the enthusiasm that such an innovation introduces into the teaching process for both teachers and pupils, tests show greater comprehension of factual material, a result definitely indicating that talking pictures are a visual aid of permanent value.

* Copies of this report may be obtained from Fox Film Corporation, 850 Tenth Ave., New York City.

The Advent of Psychology as a Unit in Junior High School Science

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Psychology is definitely forcing its way into the general science course. There are probably several explanations for this. It may be that it is arriving by way of the biological side since the older psychology owed much to biology. It may be that it is edging its way into the general science course as an appendix to the general health units. Equally possible is the thought that it has come as a result of the growing demand for character material based upon that phase of science which deals with motives and habits (character), namely, psychology and mental hygiene. The true explanation probably lies in all of these.

Some of the newer text and reference books in general science and health contain psychological and mental health material other than that which ordinarily enters the subject with biology and physiology. Among these are (1) Hunter and Whitman, *Problems in General Science;* (2) Andress and Brown, *Science and the Way to Health;* (3) Newmayer and Broome, *The Human Body and Its Care;* and (4) Winslow and Hahn, *The New Healthy Living.*

In the Cleveland "Experimental Units for a Course of Study in Science, including Health" the first unit for grade 8 is devoted to "the behavior characteristics of living things with emphasis on the human organism." The first part of this unit includes topics under mechanical behavior, emotions, habits, reasoning and physiology of the nervous system. The second part is devoted to mental hygiene and is subdivided into three topics: (1) Life—an adjustment; (2) Things indicating poor adjustment to life's problems; (3) Ways of meeting problems squarely.

Psychology has a definite contribution to make to general science. There are definite possibilities of character education present. All of the indirect values present in other units are there plus certain more direct values. The general aims of such units might well be: (1) To lead the student to comprehend his responsibility for his own adjustment; (2) To lead the student to see that certain urges are not peculiar to himself but are instead common to his species; (3) To lead the student to see the necessity for making proper adjustments to life and to want to make these adjustments; (4) To lead the student to want to, and to know how to meet his problems squarely rather

than by either excessive retreat or attack; (5) To lead the student to want to, and to know how to practice control of the emotions; (6) To lead the student to recognize certain things that indicate an undesirable adjustment to life and other things which point to a desirable adjustment.

As in other general science topics there are abundant opportunities for experiments. In Thomas A. Edison School, Cleveland's school for problem boys, we have developed a group of psychological experiments under the title of "Experiments in Human Behavior" for use by students in eighth-grade science. In the main these have been brought down from college experimental psychology and adapted to the junior-high-school level. The title of some of these experiments will give an idea of their nature: a seeing echo; flexibility of habit; errors of association; reading meanings into things; bias; and reliability of witnesses. The power of such experiments to add interest to the unit can well be imagined.

In the mental health unit of general science as taught in the problem-boy school, several techniques are used. Several lesson pamphlets have been developed which, so far as is known, are the only ones of their kind. Among these is one with the title, "Growing Up." It aims to lead the student to see the infantile nature of certain ways of thinking and doing. Certain behavior manifestations more or less common to the problem boy are partially explained in the light of their juvenile nature. The aim is to cause the boy to want to grow up. At the end he is helped to apply the things he has read in the pamphlet through the technique of having him classify numerous acts.

Education for a great many pupils will end during the junior-high-school period. If they are ever to learn to apply the principles of psychology and mental hygiene to their own lives it must be then. How many fewer people would be enjoying a retreat from the bumps of life via sickness, phantasy, running away, and the like, if they really and consciously understood the nature of such acts!

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Watson, P. M. "Cleveland's School for Problem Boys." *Journal of Education,* 112:499-50; December 15, 1930.

Watson, P. M. "Centers Life of School in Boy's Success." *School Topics.* Vol XI, No. 7, December 11, 1928.

Moore, H. K. "Problem Boy is Linked to his Failures." *School Topics.* Vol. XIII, No. 10, February 17, 1931.

Thomas A. Edison School, From the Report of the Superintendent of Schools to the Board of Education of the City School District of Cleveland for the school year 1929-1930.

Science Reading Material for Pupils and Teachers — III*

C. M. Pruitt
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Part IV. High School Textbooks

A. Biology

Atwood—*Biology*. P. Blakiston's Son and Co. $1.68. 1927.
Gruenberg—*Biology and Human Life*. Ginn and Co. $1.72. 1925.
Hunter—*Problems in Biology*. American Book Co. $1.76. 1931.
Kinsey—*Introduction to Biology*. J. B. Lippincott Co. $1.68. 1926.
Linville, et al—*General Zoölogy*. Ginn and Co. $1.80. 1929.
Meier and Meier—*Essentials of Biology*. Ginn and Co. $1.68. 1931.
Moon—*Biology for Beginners*. Henry Holt and Co. $1.72. 1926.
Peabody and Hunt—*Biology and Human Welfare*. The Macmillan Co. $1.68. 1924.
Smallwood, Reveley and Bailey—*The New General Biology*. Allyn and Bacon. $1.60. 1929.
Pool, Evans and Caldwell—*Botany*. Ginn and Co. $1.64. 1928.

B. Chemistry

Berry—*Chemistry Applied to Home and Community*. J. B. Lippincott Co. $3.50. 1926.
Black and Conant—*Practical Chemistry*. The Macmillan Co. $1.80. 1927.
Bradbury—*A First Book in Chemistry*. D. Appleton and Co. 1928.
Brownlee, et al—*First Principles of Chemistry*. Allyn and Bacon. $1.60. 1931.
Bruce—*High School Chemistry*. World Book Co. $1.60. 1928.
Dull—*Modern Chemistry*. Henry Holt and Co. $1.80. 1931.
Emery, et al—*Chemistry in Everyday Life*. Lyons and Carnahan. $1.76. 1928.
Fletcher—*Beginning Chemistry*. American Book Co. $1.60. 1929.
Gordon—*Introductory Chemistry*. World Book Co. $2.20. 1930.
Gray, et al—*Fundamentals of Chemistry*. Houghton Mifflin Co. $1.68. 1929.
Greer and Bennett—*Chemistry*. Allyn and Bacon. $1.80. 1927.
Holmes and Mattern—*Elements of Chemistry*. The Macmillan Co. $1.80. 1927.

* Continued from October and December issues and concluded in this issue.

Irvin, et al—*Beginning Chemistry and Its Uses.* Row, Peterson and Co. $1.60. 1927.

Kendall-Smith—*Elementary Chemistry.* The Century Co. $1.80. 1924.

Smith—*Elementary Chemistry.* The Century Co. $1.80. 1924.

McPherson, et al—*Chemistry for Today.* Ginn and Co. $1.80. 1930.

Smith and Mess—*Fundamentals of Modern Chemistry.* Henry Holt and Co. $1.00. 1928.

C. General Science

Bowden—*Foundations of Science.* P. Blakiston's Son and Co. $1.68. 1931.

Caldwell and Curtis—*Introduction to Science.* Ginn and Co. $1.68. 1929.

Caldwell and Eikenberry—*Elements of General Science.* Ginn and Co. $1.68. 1926.

Clement, Collister and Thurston—*Our Surroundings.* Iroquois Publishing Co. $1.68. 1928.

Hunter and Whitman—*Problems in General Science.* American Book Co. $1.72. 1930.

Pieper and Beauchamp—*Everyday Problems in Science.* Scott, Foresman and Co. $1.60. 1925.

Van Buskirk, et al—*The Science of Everyday Life.* Houghton Mifflin Co. $1.60. 1930.

Webb and Didcoct—*Early Steps in Science.* D. Appleton and Co. $1.68. 1927.

Wood and Carpenter—*Our Environment* (3 Volumes). Allyn and Bacon. *Our Environment, Its Relation to Us.* $1.20. 1928. *Our Environment, How We Adapt Ourselves To It.* $1.60. 1928. *Our Environment, How We Control It.* $1.80. 1928.

D. Physics

Black and Davis—*New Practical Physics.* The Macmillan Co. $1.68. 1929.

Duff and Weed—*Elements of Physics.* Longmans, Green and Co. $2.20. 1928.

Dull—*Modern Physics.* Henry Holt and Co. $1.72. 1929.

Fuller, Brownlee and Baker—*Elementary Principles of Physics.* Allyn and Bacon. $1.80. 1925.

Henderson—*The New Physics of Everyday Life.* Lyons and Carnahan. $1.60. 1930.

Lynde—*Everyday Physics.* The Macmillan Co. $1.80. 1930.

Millikan and Gale—*Elements of Physics.* Ginn and Co. $1.64. 1927.

Whitman—*Household Physics.* John Wiley and Sons. $2.50. 1924.

PART V. WORKBOOKS

A. Biology

ADELL, DUNHAM and WELTON—*A Biology Workbook.* Ginn and Co. $1.32. 1929.

B. Chemistry

POWERS and JOHNSON—*Workbook in Chemistry.* Allyn and Bacon. $1.00. 1931.

C. General Science

CALDWELL and CURTIS—*Workbook in General Science.* Ginn and Co. $0.72. 1930.

PERSING and PERSING—*Workbook in General Science.* Harter School Supply Co. $0.60. 1927.

LAKE, WELTON and ADELL—*General Science Workbook.* Silver, Burdett and Co. $1.40. 1930.

VAN BUSKIRK, et al—*Workbook in General Science.* Houghton Mifflin Co. $0.72. 1930.

WATKINS and BEDELL—*Learning and Test Exercises in General Science.* The Macmillan Co. $0.60. 1931.

WOOD and CARPENTER—*Science Discovery Book* (3 volumes) Allyn and Bacon. $3.00. 1931.

D. Physics

HURD—*Work Testbook in Physics.* The Macmillan Co. $0.64. 1930.

PART VI. TESTS IN SCIENCE

A. Biology

BLAISDELL—*Instructional Tests in Biology.* World Book Co.

COOPRIDER—*Information Exercises in Biology.* Public School Publishing Co.

LAIDLAW and WOODY—*Michigan Botany Test.* Public School Publishing Co.

OAKES and POWERS—*Biology Test* (Forms A and B). Bureau of Publications. Teachers College, Columbia University.

PRESSON and KING—*Achievement Tests in Biology.* World Book Co.

RUCH and COSSMAN—*Biology Test* (Forms A and B). World Book Co.

B. Chemistry

COLUMBIA—*Columbia Research Bureau Chemistry Test* (Forms A and B) World Book Co.

GERRY—*Test of High School Chemistry* (Forms A and B). Ginn and Co.

GLENN and WELTON—*Instructional Tests in Chemistry.* World Book Co.

POWERS—*General Chemistry Test* (Forms A and B). World Book Co.

IOWA—*Training Test in Chemistry* (Forms A and B). Bureau of Educational Research and Service. University of Iowa, Iowa City, Iowa.

IOWA—*Aptitude Test in Chemistry* (Forms A and B). Bureau of Educational Research and Service. University of Iowa, Iowa City, Iowa.

RICH—*Chemistry Test for High Schools* (Forms Gamma and Epsilon). Public School Publishing Co.

RIVETT—*Chemistry Test* (Forms I, II and III). B. J. Rivett. Northwestern High School, Detroit.

C. General Science

CALDWELL and CURTIS—*Test Book in General Science.* Ginn and Co.

DVORAK—*General Science Tests* (3 Forms). Public School Publishing Co.

PIEPER and BEAUCHAMP—*Unit Tests in General Science.* Scott, Foresman and Co.

POWERS—*General Science Test* (Forms A and B). Bureau of Publications, Teachers College, Columbia University.

RUCH and POPENOE—*General Science Test* (Forms A and B). World Book Co.

VAN WAGENEN—*Reading Scales in General Science* (Forms A and B). Public School Publishing Co.

WILSON—*Objective Tests in General Science.* Houghton Mifflin Co.

D. Physics

BLACK and BURLINGAME—*Physics Tests* (Forms A and B). Ginn and Co.

CAMP—*Iowa Physics Tests.* Public School Publishing Co.

GLENN and OBOURN—*Instructional Test in Physics.* World Book Co.

HUGHES—*Physics Scales* (Four Forms). Public School Publishing Co.

HURD—*Final Test in Physics.* Bureau of Publications, Teachers College, Columbia University.

PETERS and WATKINS—*Objective Tests for High School Physics.* C. J. Peters, University High School, Columbia, Missouri.

SANGREN and MARBURGER—*Michigan Instructional Tests in Physics.* Public School Publishing Company.

IOWA—*Training Test in Physics* (Forms A and B). Bureau of Educational Research and Service. University of Iowa, Iowa City, Iowa.

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THURSTONE—*Vocational Guidance Test in Physics.* World Book Co.

PART VII. GUIDES FOR IDENTIFICATION

BERRY—*Northern Woodlot Trees.* World Book Co. $1.20. 1924.

BERRY—*Western Forest Trees.* World Book Co. $1.20. 1924.

BERRY—*Southern Woodland Trees.* World Book Co. $1.20. 1924.

CHAPMAN—*Handbook of Birds of Eastern North America.* D. Appleton and Co. $4.00. 1912.

CURTIS—*A Guide to Trees.* Greenberg, Publisher, Inc. $1.50. 1925.

DOWNING—*A Field and Laboratory Guide in Biological Nature Study.* Longmans, Green and Co. $1.50. 1918.

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DURAND—*A Field Book of Ferns.* G. P. Putnam's Sons. $2.50. 1928.

DURAND—*Wild Flowers and Ferns in Their Homes and in Our Gardens.* G. P. Putnam's Sons. $3.50. 1925.

ILLICK—*Tree Habits: How to Know the Hardwoods.* American Tree Association. $4.00. 1924.

LOOMIS—*Field Book of Common Rocks and Minerals.* G. P. Putnam's Sons. $3.50. 1923.

LUTZ—*Field Book of Insects.* G. P. Putnam's Sons. $5.00. 1921.

MATHEWS—*Field Book of American Wild Flowers.* G. P. Putnam's Sons. $3.50. 1921.

MATHEWS—*Field Book of Wild Birds and Their Music.* G. P. Putnam's Sons. $3.50. 1921.

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MORGAN—*Field Book of Ponds and Stream.* G. P. Putnam's Sons. $3.50. 1930.

PALMER—*Field Book of Nature Study.* Slingerland—Comstock Co. $2.50. 1929.

REED—*Bird Guide.* Doubleday, Doran Co. $1.50. 1925.

PART VIII. PROFESSIONAL BOOKS FOR SCIENCE TEACHERS

BAIRD—*A Study of Biology Notebook Work in New York State.* Bureau of Publications, Teachers College, Columbia University. $1.50. 1929.

BILLIG—*A Technique for Developing Content for a Professional Course in Science for Teachers in Elementary Schools.* Bureau of Publications, Teachers College, Columbia University. $1.50. 1929.

BROWN and BIRD—*Motion Pictures and Lantern Slides.* Bureau of Publications. Teachers College, Columbia University. $1.00. 1931.

Brownell and Wade—*The Teaching of Science and the Science Teacher.* The Century Co. $2.00. 1925.

Carpenter—*Certain Phases of the Administration of High School Chemistry,* Bureau of Publications, Teachers College, Columbia University. $1.50. 1925.

Chappelear—*Health Subject Matter in Natural Sciences.* Bureau of Publications, Teachers College, Columbia University. $1.50. 1929.

Craig—*Certain Techniques Used in Developing a Course of Study in Science for the Horace Mann Elementary School.* Bureau of Publications, Teachers College, Columbia University. $1.50. 1927.

Curtis—*A Synthesis and Evaluation of Subject-Matter Topics in General Science.* Ginn and Company. $1.00. 1929.

Curtis—*Digest of Investigations in the Teaching of Science.* P. Blakiston's Son and Co. $2.00. 1925.

Curtis—*Second Digest of Investigations in the Teaching of Science.* P. Blakiston's Son and Co. $3.00. 1931.

Downing—*Teaching Science in the Schools.* University of Chicago Press. $2.00. 1925.

Eikenberry—*The Teaching of General Science.* University of Chicago Press. $2.00. 1922.

Caldwell and Finley—*Biology in the Public Press.* Bureau of Publications, Teachers College, Columbia University. $1.25. 1923.

Finley—*Biology in Secondary Schools and the Training of Biology Teachers.* Bureau of Publications, Teachers College, Columbia University. $0.80. 1926.

Frank—*High School Science Terminology.* J. O. Frank (Oshkosh, Wisconsin.) $2.50. 1930.

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Hurd—*Problems of Science Teaching at the College Level.* University of Minnesota Press. $2.00. 1929.

Johnson—*Curricular Problems in Science at the College Level.* University of Minnesota Press. $2.00. 1930.

Kilander—*Science Education in the Secondary Schools of Sweden.* Bureau of Publications, Teachers College, Columbia University. $1.75. 1931.

Klopp—*Relative Merits of Three Methods of Teaching Science in the High School.* Central Association of Science and Mathematics Teachers. $1.00. 1930.

Laton—*Psychology of Learning Applied to Health Education Through Learning Biology.* Bureau of Publications. Teachers College, Columbia University. $1.50. 1929.

Lerrigo—*Health Problem Sources.* Bureau of Publications, Teachers College, Columbia University. $1.50. 1926.

Meier—*Health Subject Matter in Science Textbooks.* Bureau of Publications, Teachers College, Columbia University. $1.00. 1927.

Meier—*Natural Science Education in the German Elementary Schools.* Bureau of Publications, Teachers College, Columbia University. $1.75. 1930.

Noll—*Laboratory Instruction in the Field of Chemistry.* University of Minnesota Press. $2.00. 1930.

Powers—*A Diagnostic Study of the Subject Matter of High School Chemistry.* Bureau of Publications, Teachers College, Columbia University. $1.00. 1924.

Powers—*A Vocabulary of Scientific Terms for High School Students.* Bureau of Publications, Teachers College, Columbia University. $0.30. 1926.

Roller—*Terminology of the Physical Sciences.* University of Oklahoma Press. $1.00. 1929.

Rusk—*How to Teach Physics.* J. B. Lippincott Co. $1.80. 1923.

Strang—*Subject Matter in Health Education.* Bureau of Publications, Teachers College, Columbia University. $1.50. 1926.

Twiss—*A Textbook in the Principles of Science Teaching.* The Macmillan Co. $2.00. 1927.

U. S. Bureau of Education—*Cardinal Principles of Education.* Bulletin 35. $0.10. 1918.

U. S. Bureau of Education—*Reorganization of Science in Secondary Schools.* Bulletin 26. $0.10. 1920.

U. S. Bureau of Education—*Laboratory Layouts in Science.* $0.10. 1927.

Van de Voort—*Teaching of Science in Normal Schools and Teachers Colleges.* Bureau of Publications, Teachers College, Columbia University. $1.50. 1927.

Woodring, Oakes and Brown—*Enriched Teaching of High School Science.* Bureau of Publications, Teachers College, Columbia University. $2.75. 1928.

Part IX. Periodical Literature

A. Professional Magazines for Teachers

Journal of Chemical Education—654 Madison Avenue, New York City. $2.00.

School Science and Mathematics—404 N. Wesley Ave., Mt. Morris, Illinois. $2.50.

Science Education—New Jersey State Teachers College, Upper Montclair, New Jersey. $1.50.

The Science Classroom—Popular Science Monthly—225 W. 39th St., New York City. $0.25.

Turtox News—General Biological Supply House, 761-763 E. 69th Street, Chicago, Illinois. Free.

B. Science Magazines for Pupils and Teachers

Bird Lore—Bird Lore Magazine, Harrisburg, Pa. $1.50.

Chemistry Leaflet—654 Madison Avenue, New York City. $1.75.

Current Science—40 S. Third Street, Columbus, Ohio. $1.00.

Guide to Nature—Sound Beach, Conn. $1.50.

Hygeia—535 N. Dearborn Street, Chicago, Illinois. $3.00.

Journal of Chemical Education—654 Madison Avenue, New York City. $2.00.

Literary Digest (Science section)—354 Fourth Avenue, New York City. $4.00.

The Monthly Evening Sky Map—244 Adams St., Brooklyn, New York. $1.50.

National Geographic Magazine—National Geographic Society, Hubbard Memorial Hall, Washington, D.C. $3.50.

Nature Magazine—American Nature Study Association, 1214-16th Street, Washington, D.C. $3.00.

Popular Mechanics—200 E. Ontario Street, Chicago, Illinois. $2.50.

Popular Science Monthly—225 W. 39th Street, New York City. $2.50.

Radio News—53 Park Place, New York City. $2.50.

Science—The Science Press—Grand Central Terminal, New York. $6.00.

Scientific American—24 W. 40th Street, New York City. $4.00.

Scientific Monthly—The Science Press, Grand Central Terminal, New York City. $5.00.

Science News-Letter—Science Service, Constitution Avenue at 21st Street N.W., Washington, D.C. $5.00.

An Attempt to Vitalize Chemistry Teaching in the High School Through a Modified Form of the Unit-Assignment Technique

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EDITOR'S NOTE: *This article appears in two instalments. The one in this issue presents a typically illustrative unit with some of the principles of organization. The part to appear in a subsequent issue will describe the application of the unit and give the experimental results of its use.*

Introduction

The Commission on Curriculum of the Department of Superintendence, 1928, defined secondary education as "the organized effort of society through its schools to aid the normal processes of growth and development and to produce desirable changes in attitudes, ideals, and behavior of youth during the period of early and middle adolescence. This organized effort will require the tools and materials, the processes, and the adaptation of both of these to the needs of boys and girls."

The tools or materials at the disposal of the chemistry teacher are the elements of subject matter, that body of facts, concepts, techniques, and human experiences, embraced by the science of chemistry. The writer, in adapting the unit method to classroom use in the teaching of chemistry, has tried to organize this body of subject matter more in keeping with the above conception of education. If chemistry is to justify a place in the light of this newer conception, it should be so organized and directed that the student will be better equipped, emotionally, intellectually, and physically, to take his place in the world, as a result of having studied the subject. He should while studying chemistry, acquire knowledges and habits of safeguarding his health and maintaining his physical efficiency. He should be able to contribute new abilities to the promotion and maintenance of the material factors of the home. He should be discovering his vocational abilities. He should be acquiring avenues through which to use, with profit and

* The author wishes to acknowledge that many phases of the technique, and the inspiration for adapting it to classroom use grew out of his association with Professor Charles J. Pieper of New York University; and, also, that much help came from fellow workers in the teaching field who have been willing to report their experiences in the same spirit in which the writer has endeavored to report his, namely, that of helpfulness to the teacher of chemistry.

pleasure, the large amount of leisure time the present organization of industry and society places at his disposal. His chemistry should give him mastery of a body of new ideas, understandings and appreciations that would ultimately enrich his philosophy of life and his attitude toward society and the physical universe. These, and a vast number of more detailed attendant learnings should be achieved while mastering the chemistry content itself. If these are not achieved, others of a less worthy nature will be, for learning is never single. In the absence of a clearly defined procedure on the part of the chemistry teacher, the pupil may be acquiring habits of laziness, careless habits of work, dislike for the subject and teacher, and perhaps disgust with school in general. So while planning the work, the subject must be considered in relation to the attitudes it will promote, the new interests it will stimulate, the behaviors it will initiate, and the new skills it will develop, as well as the knowledges it will achieve, that the end might be an integrated personality.

As to the method for achieving this end, one may turn with profit to Burnham's *The Normal Mind* for the essentials: (1) a suitable task; (2) a coördinated plan to make the activity purposeful, and (3) freedom to carry out the plan. These, on reflection, will be seen to embody the essence of a happy mental state, whether in child or adult, in school or out.

Organization of the Unit

If chemistry is to furnish a suitable task with a coördinated purposeful plan, it will call for a recasting of the body of subject matter into significant learning units. Such a unit will embody some important and comprehensive part of the science of chemistry so that when the pupil is working, he can see the relation of what he is doing in its larger context, for as Thayer has pointed out in *The Passing of the Recitation,* "All serious human activity which grips one at all, is integrated with larger plans and other ends that overflow the present moment."

The subject of metals will typify the writer's experience with the unit method. Textbooks show metals to be treated in from seven to ten chapters, based on the conventional family groupings. Each chapter follows the same general pattern: occurrence, method of refining, properties, uses, and compounds. This approach to the study of metals is just as meaningless and confusing for the beginner in chemistry as for the mechanic to begin to assemble materials for a house with no knowledge of the integrated plan and specifications.

The unit assignment method would regard the subject of metals as a significant learning unit and would assemble the whole subject into a single unitary organization. If the properties of metals should then be considered

a valid factor to include, it would complete that study with a large number of metals in a comparative way. The pupil will then acquire a unified concept of metals as a class. In like manner, he may gain a comprehensive understanding of the occurrence of metals, the ways in which metals are refined, etc.

By the time such a study is completed, there have been achieved broad comprehensive understandings and appreciations about metals. Facts have been used only as a means of achieving the concepts, the new attitudes, and new interests, which may be termed the end products of true learning.

The complete unit set-up consists of five parts: (1) major and minor conceptions; (2) behavior objectives or attendant learnings; (3) pretest; (4) study plan; (5) unit achievement test.

The major and minor conceptions may be regarded as the chemistry knowledge objectives. (See plan of unit, page 212.) They constitute the point of departure for the teacher and point of arrival for the student. They constitute the chemistry understandings it is desired the pupil will possess as a result of pursuing the work of the unit. They, accordingly, serve as a guide to the teacher in the selection and organization of study activities to that end.

The behavior objectives constitute that body of attendant learnings in the nature of attitudes, appreciations, behaviors, skills, and secondary knowledges, which it is thought the particular unit is potentially capable of promoting. (See unit, page 213.) These, again, are to serve the thinking of the teacher. With these in mind, the spirit of the unit, both in the stages of organization and administration, is more apt to be guided in the direction of their achievement.

The pretest is a short objective test designed to evaluate the students' previous knowledge as related to the unit. (See unit outline, page 214.) The results may reveal some pupils possessed of fairly adequate knowledge of certain phases of the unit. In such cases, these pupils can be utilized in a variety of ways in the conduct of the learning procedures that will be of profit, both to them and to the class.

The preview is the motivating stage in the unit development.* It may take the form of a straight talk by the teacher; it may be in the nature of a class discussion; or it may be a combination of lecture, questions, and discussion. Whatever it is, it must lead the class to a point where it will approach the unit with a spirit of anticipated adventure, and it must bring the class to appreciate the significance of the unit, and where it leads, without robbing it of this adventure.

* Omitted from the unit outline on account of lack of space.

The study plan is the part that goes into the hands of the class. (See unit outline, page 215.) Here the concepts have been recast into problem form. Under each problem is set up a carefully selected set of appropriate activities in the nature of readings, demonstration, and experiments which, if completed, should lead the pupil to a comprehension of the concepts implied by the problem. It is at this stage that the activities and experiences can be made to connect with the child's own interests and backgrounds. It is at this stage that those possessed of motor intelligence, those with abstract intelligence, and those with special social intelligence may each be given an opportunity to achieve success in his own way. This must be accomplished without destroying the basic skills and techniques of the unit. This is here attempted by the inclusion of a large number of special but basically related projects that may be pursued beyond the minimum essentials of the unit proper. (See unit outline, page 218.) The study plan also provides facilities that enable the pupil to measure his own growth and skill. This is achieved by the self-testing exercises placed throughout the work plan at significant points.

Finally comes the unit test which completes the unit set-up.* It is a comprehensive objective test, designed to test *understanding of major conceptions of the unit,* rather than the factual information that is incidental to the conceptual achievement.

ELEMENTARY CHEMISTRY

UNIT VIII, METALS

Major and Minor Conceptions

Unit VIII. *The common metallic elements possess characteristics that enable them to serve many uses.*

1. Metals possess peculiar physical characteristics that determine many of their uses.
   a. Metals possess a peculiar metallic lustre.
   b. Metals range in weight from light to very heavy.
   c. Metals vary in melting points from low to very high.
   d. Metals conduct electricity and heat.
   e. Most metals are both malleable and ductile.
2. Metals possess certain chemical characteristics that regulate their uses.
   a. Metals vary in their degree of chemical activity from very active to practically inactive. The more active will replace the less active.
   b. The oxides of metals are base forming.
   c. Metals and non-metals combine to neutralize each other's properties.
   d. Metallic compounds on going into solution yield the metallic ion.
   e. The soluble salts of a metal may be formed by the reaction of the metal, or its oxide, or its base, or its carbonate with the proper acid.
3. Metals may be identified by chemical test in a number of ways.
   a. Metals may be identified by replacement from their ionic solutions.
   b. Metals impart a characteristic color to fused glass or borax.

* Omitted from the unit outline on account of lack of space.

c. Metals impart a characteristic color to a flame.
d. Metals will replace hydrogen from hydrogen sulphide, producing the insoluble metallic sulphide. The sulphide may in turn be identified by prescribed test.

4. Alloys are mostly mixtures of metals dissolved in each other.
   a. The properties of alloys may be markedly different from the properties of their constituents.
   b. Alloys are of great commercial value because of the elimination of certain objectionable properties and the introduction of certain desirable properties.
5. Metals are obtained in a number of different ways which depend greatly upon the activity of the metal and its chemical source.
   a. The least active metals are obtained in their native states.
   b. Some metals are obtained from their oxides by reduction with carbon.
   c. Some metals are obtained from their sulphides by roasting and then reducing with carbon.
   d. Some metals are obtained from their carbonates by roasting to their oxide and then reducing with carbon.
   e. The active metals are obtained for the most part by electrolysis of their fusible compounds.

Attendant Learnings

Attitudes, Interests, Appreciations, Abilities

1. To appreciate how science transforms the few crude materials of nature into the vast number of new and useful substances for the enrichment of life.
2. To appreciate the way that nature prepared and preserves the natural resources.
3. To acquire an intelligent attitude toward the conservation of natural resources.
4. To appreciate the romantic history of some of the metals.
5. To appreciate the chemical significance of the rare metals as standards of value.
6. To appreciate the impress chemical research has made upon the modern home through metals.
7. To appreciate how chemistry has enabled the masses to enjoy the equivalent luxuries of the rare metals at normal cost.
8. To appreciate the relationship of metals to the electrical, automobile, motion picture, and other major industries.
9. To appreciate how the invention of steel has modified human life.
10. To appreciate how alloying just the right quantity of rare metals with steel will confer upon it peculiar and valuable properties and extend its uses manifold.
11. To understand the nature of rusting, the vast losses through rust, how to prevent it, and the urgent need for cheap non-rusting metals.
12. To know the nature of metallic corrosion in general.
13. To speculate upon the possibilities in building, manufacturing, and science of the future advent of much needed new metals.
14. To understand the action of foods upon metals, and to be able to control it in cooking and canning.
15. To know the physiological effects of metals and their salts, and how to safe-guard the health against their harmful effects.
16. To appreciate the relation of metals to medicine, and their germicidal action.
17. To be able to use metal cleaners more effectively.
18. To be able to use and preserve protective coatings more effectively.
19. To care for tools, instruments, and cutlery more intelligently.
20. To use solders more effectively.
21. To be able to identify metals by their properties.
22. To be able to understand the terminology of metals and the properties of metals well enough to buy more critically and wisely.
23. To know how to do metal etching, electroplating, metal casting and alloying as pastime pursuits.

Pretest

I. Select from the list of reasons in question II the one that best accounts for the following uses of metals. Place the number of the term in the parenthesis at the right.

1. Gold for jewelry .... (   )
2. Copper for electric cables .... (   )
3. Steel for bridge cables .... (   )
4. Aluminum for airplanes .... (   )
5. Tungsten wire for electric lamps .... (   )

II. Below is a list of nine metals accompanied by suggested uses. From the list of reasons select the one which would make the proposed use invalid and place its number in the appropriate parenthesis.

1. Platinum for airplanes .... (   )
2. Cast iron for automobile springs .... (   )
3. Silver for trolley cables .... (   )
4. Wrought iron for railroad tracks .... (   )
5. Gold for all parts of the automobile except springs .... (   )
6. Magnesium for stoves .... (   )
7. Aluminum for ship anchors .... (   )
8. Tungsten for solder .... (   )
9. Sodium for cooking utensils .... (   )

Reasons

1. too light	7. too soft
2. chemically too active	8. high tensile strength
3. high melting point	9. low kindling temperature
4. high electrical resistance	10. too active chemically
5. too heavy	11. chemically inactive
6. too brittle	12. high electrical conductivity

III. Select the terms from the left that match best with those at the right. Place the the numbers in the accompanying parenthesis.

1. Alloy	1. metal test .... ( )
2. cast iron	2. wrought iron .... ( )
3. gold	3. brass .... ( )
4. reverberatory furnace	4. malleable .... ( )
5. mercury	5. amalgam .... ( )
6. hydrogen sulphide	6. blast furnace .... ( )

IV. Answer as briefly as possible.

1. Mention three ways in which metals differ from non-metals.
2. Name five metals that are elements.
3. Name five metals that are not elements.
4. State as many ways as you can to prove that copper sulphate contains combined copper.
5. What is the meaning of the statement, "A new metal has been invented"?

Assignment

Unit Problem. *What is the nature of the common metallic elements?*

Problem 1. What are the physical properties of the common metals and their corresponding uses?

Problem 2. What are the important chemical properties of metals and their corresponding uses?
Problem 3. How are the common metals identified by chemical test?
Problem 4. What are alloys and how are they made and used?
Problem 5. How do the metals occur in nature and how are they obtained?

STUDY PLAN

PROBLEM 1. What are the physical properties of the common metals and their corresponding uses?

Exercises—

To recognize the common metals:

1. Study *Chemistry Leaflet,* "The Order of Discovery of the Elements." Chemical Foundation, Volume II, No. 1, pp. 4-8. From this summary, write a list of all the metals that are familiar to you with a brief note about each. This will constitute the metals we will work with in the unit.
2. Observe as many of the metals as occur in the laboratory. Compare their luster with that of glass and enameled surfaces. Try to describe how the lustre differs.

To note how metals conduct electricity:

3. With a dry cell, ammeter, and one meter of No. 30 copper wire connected in series, measure the current that will pass through. Repeat with iron, german silver, and others.
4. Write your list of metals in the order of their conductivity. *Hand Book of Chemistry and Physics.* Chemical Rubber Company, Cleveland, 1929, p. 465. Are there any that will not conduct electricity?

To note how metals will conduct heat:

5. Demonstrate the relative heat conducting capacity of several metals by a conductometer.
6. Make a list of your metals in the order of their conductivity. *Hand Book of Chemistry and Physics,* pp. 426-428.

To study the melting points of as many metals as possible:

7. By consulting the index of your text, find the melting points of as many metals as possible.
8. Go down the list and melt as many as possible with the Bunsen flame and porcelain crucible. From there on, see how many can be melted with blow-pipe and charcoal.

To note the weight of metals:

9. List your metals in the order of increasing density. Note the very light ones and the very heavy ones. *Handbook of Chemistry and Physics.*

To learn about the malleability and ductility of metals:

10. Read *Chemistry Leaflet.* Pp. 1-25, Aluminum Foil, p. 10.
11. Examine copper foil, tin foil, lead foil, gold leaf, and silver leaf. Measure the thickness of some of these with the micrometer caliper.
12. Read an article on Gold Beating.
13. Read an article on Wire Drawing.
14. A student furnish a wire die and draw No. 24 copper wire down to No. 30.

Test Exercise. Write a discussion in which you illustrate by two or more examples how each of the properties studied prove useful. You will find many suggestions in the *Chemistry Leaflets* on display.

PROBLEM 2. What are the important chemical properties of metals and their corresponding uses?

Exercises—

To learn how metals vary in their degree of chemical activity.

1. Read and copy for further use the activity list. *Chemistry Leaflet,* 2-3, p. 1.

2. Experiment. Make solutions of compounds of five or more metals in the activity series below tin, as: lead, copper, mercury, and silver. Replace the metals from these compounds by lowering into each a strip of some metal from higher up the activity list. Collect the replaced metal and melt it down to a globule.
3. Experiment. Put a drop of mercury into about 50 c.c. silver nitrate solution. Let it set for about an hour. Explain the action.
4. Demonstration. To make copper look like silver. Greer and Bennett, *Chemistry for Boys and Girls*. Allyn and Bacon, 1925, p. 283.
   Test Exercise.
   a. Which metals are found free in nature? Why?
   b. Name five metals that cannot exist free. Why?
   To recall by way of review other important chemical properties of metals:
5. Recall in Unit I the base forming action of metals and metallic oxides with water.
   Test Exercise. Write equations to illustrate four of each.
6. Recall that metals will combine only with non-metals.
   Test Exercise. From past experience write equations. Write equations for five reactions of metallic with non-metallic elements. Describe briefly the substances before and after the reaction.
7. Recall Unit V. how metallic compounds ionize.
   Test Exercise. Write a paragraph explaining how an electric current could be used to get the copper from a lump of copper chloride salt.
8. Recall Unit VI, how the salts of metals are formed.
   Test Exercise. Write a paragraph stating the four ways of making metallic salts and one equation to illustrate each way.

Problem 3. How are the common metals identified by chemical test?

Exercises—

To learn how metals may be identified by the borax bead tests:

1. Experiment 70—Borax Bead Test, Black, *Exercises in Chemistry*. Macmillan Company, 1929, p. 151.
2. Two or more students make some borax beads. Greer and Bennett, *Chemistry for Boys and Girls*, pp. 162-164.
   To learn how the flame test may be used to identifiy metals:
3. Experiment 47—Flame Tests, Black, p. 106. Use salts of sodium, potassium, lithium, calcium, strontium, barium, copper, and antimony.
4. Experiment, to show that a brass pin or a five cent piece contains copper. Put the pin or nickel into nitric acid and apply the flame test.
   To learn how hydrogen sulphide is used to identifiy metals:
5. Read Black and Conant, Hydrogen Sulphide. *Practical Chemistry*, Macmillan Company, par. 174-176.
6. Demonstration. Black, experiment 26, p. 66. Parts (c) and (e) only. Try compounds of copper, zinc, chromium antimony, sodium, lead, tin, and cadmium.
   Test Exercise. If you were given a chloride salt, write an explanation of three ways you might identify which metallic chloride it was.

Problem 4. What are alloys and how are they made and used?

Exercises—

To note the composition and properties of alloys:

1. Read Gray, Sandifur and Hanna. *Fundamentals of Chemistry*, Houghton Mifflin Company, 1924, pp. 21-26.
2. Read Fletcher, Smith and Harrow, Alloys. *Beginning Chemistry*, American Book Company, 1929, pp. 294-299.
3. Read *Chemistry Leaflet*. Pp. 1-25. Duralumin, pp. 5-6.

4. Read *Chemistry Leaflet*. Pp. 1-26. Alloys of Tin, pp. 17-18.
5. Read Howe and Turner, Metals in the Kitchen. *Chemistry and the Home,* Charles Scribner's Sons, 1927, Ch. 3, pp. 52-66.
   Test Exercise. Write a paragraph to explain the effects that may be obtained by alloying metals. Use examples for illustrative purposes.
6. List the composition and properties of the following alloys: Woods metal, bell metal, brass, german silver, steel, invar, chromel, nickel-chrome steel, gold coin, type metal, solder, dentists amalgam, silver coin, Babbitt, white gold, Stainless steel and duralumin.
   Test Exercise. Write a paragraph stating the respects in which any four of these differ from their components.
7. Each student prepare at least one alloy. Melt with blow-pipe on the asbestos mat the metal with the highest melting point and add the other metals in the order of decreasing melting point. Apportion the amounts so as to have a good size globule of the alloy when finished.

PROBLEM 5. How do the metals occur in nature and how are they obtained.

Exercises—

1. Read Black and Conant, *Some General Principles of Metallurgy*. Par. 452-454.
   Test Exercise. (a) What three classes of ores are generally used for the extraction of metals? (b) Look through your text and write two examples to illustrate each ore. (c) What is the general method employed in refining each of these classes of ores?
   To note how metals in the free state are recovered:
2. Observe the samples of gold, copper, and silver ores on display.
3. Study Black and Conant. Gold, par. 505.
   To note how sulphide and oxide ores are refined:
4. Study Black and Conant. Copper, par. 449-452. Zinc. Par. 455.
   To learn how the different types of iron are manufactured:
5. Study Black and Conant. How Cast Iron is Made. Par. 428-429. Master the chemical action of the ore, coke and flux. Master the mounted diagram of the Blast Furnace group.
6. Observe the specimens on products of the blast furnace on display.
   Test Exercise. (a) Explain the three distinct chemical processes that take place in the furnace. (b) Explain the functioning of the stoves. What is the slag? How is the furnace discharged?
7. Study Black and Conant. Par. 130. Master the reverberatory furnace and the chemical process of making wrought iron.
   Test Exercise. Explain what constitutes the charge of the reverberatory furnace and the chemical reactions that produce the wrought iron.
8. Study Black and Conant. Par. 431, Steel, par. 433, Bessemer Steel. Master the mounted diagrams of Bessemer Converters.
9. Read Cloyd L. Darrow, Masters of Steel. *Masters of Science and Invention.* Bobbs Merrill, 1922, pp. 172-180.
10. Demonstration. Read Black and Conant, par. 436. Tempering Steel. With a steel knitting needle show how it can be hardened and softened.
    Test Exercise. (a) In what ways do cast iron, wrought iron, and steel differ as to properties and uses? What is case hardened steel?

REQUIREMENTS FOR CREDIT IN UNIT VIII

There is listed below a variety of ways in which credit may be achieved in the Unit. Those listed are only intended to be suggestive. Many others will suggest themselves in the course of the unit. Any original contribution, not suggested here, will

receive credit according to its merit. The total number of points achieved will determine your grade.

In order to receive a grade of

A—you must have 130 points
B— " " " 110 "
C— " " " 90 "
D— " " " 70 "

How Credit May Be Earned

1. All must pass the Unit Test at a minimum grade of D. Any one who does not receive a grade of D in the test must repeat the work of the unit and be retested until such grade is achieved.

Grade A test	70
Grade B test	60
Grade C test	50
Grade D test	40

2. Additional credit may be earned in the following ways:

General Report:

A written report on the unit, not less than 300 words nor more than 600. The report will be graded on the degree to which it shows organized understanding of the unit.

Grade A report	60
Grade B report	50
Grade C report	40
Grade D report	30

Exhibits:	Points
1. Chart containing specimens of the metallic elements	30
2. Mounted specimens of alloys with their component metals	30
3. Samples of metallic ores and the metals derived therefrom	30
4. Metallic salts and their replaced metals	30
5. Metallic salts and the sulphides resulting from the hydrogen sulphide test	30
6. Protective coatings for metals	30
7. Exhibit a specimen each of cast iron, wrought iron, and steel, and show by small pictures or otherwise, the use each is especially adapted to serve	30

Posters:

1. Mounted series of pictures that focus on a central idea of the unit	15
2. Diagram or any commercial apparatus in connection with the unit	15

Scrapbooks:

1. To tell the story of radium	25
2. To tell the story of any metal from mine to its actual use	25
3. To tell the story of the history of a metal	25

Graphs with written interpretation:

1. In some novel way represent the production of some metal, as iron, over a number of decades	15
2. Parallel metal production graph with a graph showing the increase in national or world wealth	20

Slogans:

1. Use the protective coatings	10
2. Use of stainless steel	1C

Advertisements:	
1. For aluminum ware	15
2. For stainless steel	15
3. For some protective material	15
Models:	
1. Section model of the blast furnace showing all the essential parts	60
2. Same for reverberatory furnace	40
3. Same for Bessemer Converter	40
Miscellaneous:	
1. Poems—Represent in verse the properties or use of the metals and alloys	?
2. Cartoons—Suggestions. *Journal of Chemical Education,* Sept., Oct., and Nov., 1929	20
3. Jokes related to chemistry	5
4. Plays and dialogues—*Journal of Chemical Education,* Nov., 1928, and Dec., 1929	?
5. Cross-word puzzles in chemistry—Any term, name of apparatus, or person related to chemistry may be used	50
Demonstrations:	
1. Chemical tricks—must be performed with a masterful technique	10
2. Pyrotechnics. Make flash powder, green fire, red fire, yellow fire, boiling lead in mouth. Other demonstrations found in Henley's *Twentieth Century Formulas,* pp. 47-79	?

Projects in Biology Teaching

FRED R. CLARK
Associate Professor of Biology, Southeastern Teachers College
Durant, Oklahoma

Projects are often of considerable use to the teacher of biology in that they tie up the work of the laboratory and classroom with actual conditions in nature, thus giving the student both theoretical and practical basis for his knowledge of the subject. The writer gives below a simple project that he has used in his classes with success. It is hoped that others may be able to try it out and develop it to suit their individual needs.

Project for Biology II (Zoölogy)

You are to prepare a report on the animals of the county in which you live. This report must be written plainly in ink or be typewritten. It should be bound in covers in book form and have the title and similar information on the cover. This project will be due on the last class day of the term.

The project will cover the following items:

1. You are to make a simple map of your county. Indicate such features as cities towns, mountains, hills, rivers, lakes, highways, railroads, etc. Color areas to show forests, plains, lakes, and physical features.

2. Make a list of all species of animals that you can find to be residents of the county. Indicate whether they are native or introduced, whether they are common or rare, and their habitat. Give the phylum or group to which they belong, and if possible the genus and species.

3. Select what you think are five typical animals of the county and describe them thoroughly. First make a sketch or use a photograph of each for illustration. Cover the following points: (1) name in English (common name); (2) name in Latin (scientific name); (3) phylum and class; (4) dates observed; (5) habitat; (6) its food; (7) range; (8) where seen or observed; (9) enemies; (10) means of locomotion; (11) offense and defense; (12) reproduction and mating habits; (13) social condition; (14) its life; (15) intelligence, emotions, etc.; (16) economic importance; (17) other noteworthy characteristics.

4. Finally write an article of five-hundred words summing up the results of your studies and observations on the animals of the county.

Note: Do not confine your observations to the larger animals of the region alone. Try to study the smaller ones as well, in so far as you can do so.

Measuring the Temperatures of Stars and Planets*

Many of the instruments used in conduct of present-day scientific research are of extraordinary sensitiveness and precision. This is particularly true of a device called the thermocouple, an improved type of which Dr. Edison Pettit and Dr. Seth B. Nicholson of the staff of Mount Wilson Observatory of Carnegie Institution of Washington have developed and which they are using in measuring the heat of stars and planets.

Extraordinary Sensitivity

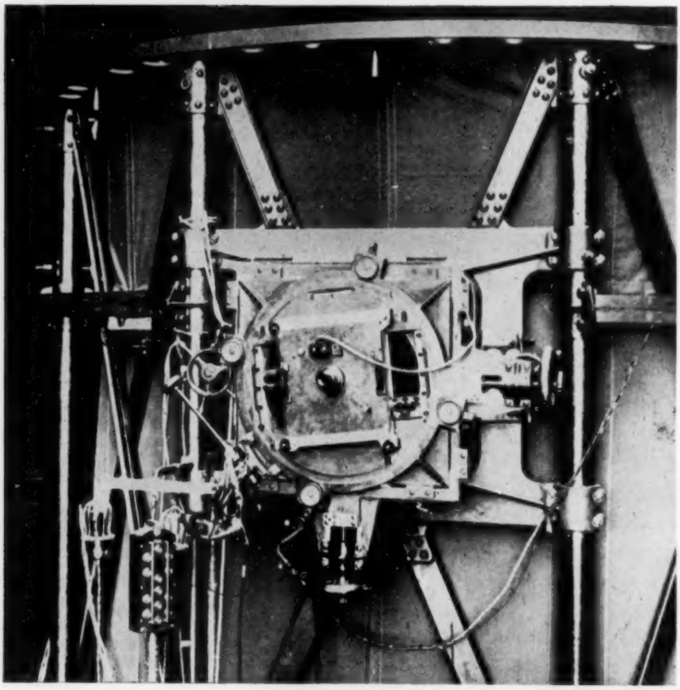
Employed as it is with the 100-inch telescope, it is so sensitive that the heat of a candle 100 miles away could be detected with it were there no loss of heat due to absorption by the atmosphere.

With this instrument these investigators have accomplished the astonishing feat of measuring the heat radiation of a star of the thirteenth magnitude. This achievement is impressive when it is recalled that stars just visible to the unaided eye are of the sixth magnitude, and that the faintest stars photographed with the 100-inch telescope at Mount Wilson, the most powerful telescope yet constructed, are of magnitude twenty-one. A star of the thirteenth magnitude, therefore is about 631 times fainter than the faintest star which most of us can see, and yet this instrument is responsive to the heat which can be focussed on it from such a star.

This exploit becomes even more impressive when it is realized that a star of the sixth magnitude, that is, one which can barely be seen, radiates upon the whole United States no more heat than the Sun radiates upon one square yard of surface. Yet, in the case of such a star, the thermocouple will show that the increase in heat on account of it is one-half of one-millionth of a degree Fahrenheit and that the electric current generated thereby is about one twenty-billionth of an ampere. This value becomes intelligible in consideration of the fact that the light in an ordinary incandescent house light is produced by a current flowing through it of from one-fourth to one ampere.

The heat of a star of the thirteenth magnitude produces a proportionately feebler current yet a current that is not too feeble to be detected and measured. The extreme sensitiveness of the thermocouple, as constructed by Dr. Pettit and Dr. Nicholson, is again illustrated in the case of stars as they rise above the horizon. The higher they ascend the brighter they appear to grow because the higher they rise the less of the Earth's atmosphere their

* Reprinted from News Service Bulletin of Carnegie Institution of Washington, Vol. II, Number 10.



Showing the thermocouple as mounted upon the 100-inch telescope at Mount Wilson Observatory of Carnegie Institution. It is this instrument, used with the 100-inch telescope, that has enabled astronomers to measure the heat radiated from stars and planets and thus to gain knowledge of conditions on celestial bodies of the greatest importance.

rays are obliged to penetrate and consequently the less their rays are absorbed. The sensitivity of the thermocouple is so great that with bright stars near the horizon the change in brightness which takes place in one minute of time can be detected.

Principle of Thermocouple

The principle upon which the thermocouple is based can readily be grasped from the above diagram. Two strips or wires of different metals, iron and copper for instance, are welded together at their ends, Z, T. One of them, the copper strip in the diagram, is cut and an instrument, G, a galvanometer, very sensitive to electric currents, is inserted. A complete

electric circuit, of which the galvanometer is a part, is thus formed. When one of the junctions, T, is heated to a higher temperature than the other, Z, an electric current is set up, the strength of which, as recorded by the galvanometer, varies as the difference in temperature varies between the two junctures.

For example, if a lighted match be held at T while Z is kept cool, the galvanometer quickly registers a current. If ice be applied to T and it becomes colder than Z the current flows in the opposite direction.

It was upon this principle that Dr. Pfund of Johns Hopkins University and Dr. Coblentz of the United States Bureau of Standards based the vacuum thermocouple which they developed and which they were the first to apply to the measurement of the heat radiation of stars. Dr. Pettit and Dr. Nicholson, in turn, improved the instrument and, with marked success, continued the systematic study of the heat radiation of stars and planets.

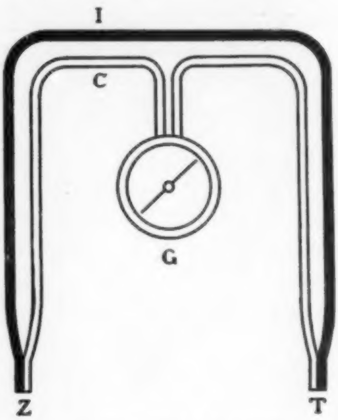


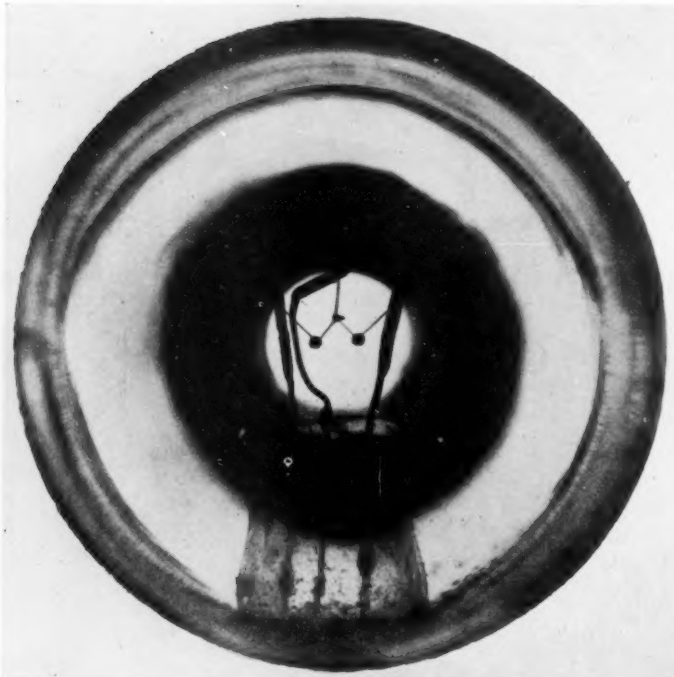
Diagram illustrating the principle upon which the thermocouple is based. It is explained in the text.

Minuteness of Instrument

The essential part of the thermocouple constructed by these investigators consists of two exceedingly minute wires fused together at the ends. One of these is of bismuth, the other is of an alloy of bismuth containing five per cent of tin. These are connected electrically to a galvanometer in such manner that the currents produced when the junctions are heated separately flow in opposite directions.

Small thin metal plates are fused over the junctions of the thermocouple wires and covered with a mixture of lamp-black and platinum-black on their exposed surfaces. These black plates absorb all the radiation from celestial objects within about two per cent and convert it into heat.

To reduce the loss of the star's heat from conduction the thermocouple is operated within a vacuum. The weight of a complete thermocouple, including the metal receiver and connecting wires, is about one-tenth of a milligram or about one one-thousandth the weight of a drop of water. The mass of the receivers themselves, the parts of the apparatus upon which the heat rays of the stars are focussed, is only about a third that of the complete thermocouple.



Looking into the eyepiece of the thermocouple (much enlarged) showing the two metal disks upon which the heat rays of the star under examination are focused. The weight of the essential part of this instrument, including the metal receivers and connecting wires, is about that of the one one-thousandth part of a drop of water. To reduce loss of the star's heat from conduction the thermocouple is operated in a vacuum.

In practice the instrument is mounted upon the 100-inch telescope, which is trained upon the star to be examined. The rays of the star fall upon the concave mirror of the telescope whereupon they are focussed upon one of the junctures of the thermocouple corresponding either to T or Z of the diagram.

Currents produced in this way are proportional to the amount of heat received by the thermocouple, so that the deflection of the galvanometer when a star is focused on the thermocouple is a measure of the heat received from the star. The deflections of the galvanometer thus induced are recorded photographically. Under favorable conditions they can be measured with extreme accuracy. These investigators have made thousands of

observations with the thermocouple leading to conclusions regarding the condition of stars and planets of the greatest importance.

Range of Star Temperatures

With this instrument it has been found that stellar temperatures range from 23,000 degrees C absolute (41,000 degrees F) for the very blue stars like Zeta Orionis, to 6,000 degrees C absolute (10,000 degrees F) for those like the Sun, and 1,800 degrees C absolute (2,800 degrees F) for the very long-period variable stars like Omicron Ceti.

The hottest stars do not necessarily give us the most heat. They radiate the most heat per unit of area, but a cooler star may be so much larger that its total radiation exceeds that of the hotter star. This is illustrated by an electric light and an electric stove. The filament of the light is much hotter than the wire coil of the stove, but the latter is so much bigger that the total energy radiated from the stove is much greater than that from the light. On the other hand, the electric lamp gives more light than the stove.

There are stars like the electric light—small, very hot and bright, with comparatively little heat outside the visual region; and there are stars like the stove—big, comparatively cool, and faint visually but with an enormous amount of heat radiation, radiation which can be measured with the thermocouple.

The coolest stars observed are the long-period variables. Because they are so cool they are very red and give very little visual light in proportion to their heat. The coolest of these which has been measured is Chi Cygni. At minimum brightness its heat is equal to that of a hot star 50,000 times as bright. It is possible that there are still cooler stars which give little or no light, the heat of which could be measured with the thermocouple, if the astronomers knew where to find them.

Measuring Star Diameters

If the temperature of a star is known and the total amount of energy radiated from it can be obtained, its diameter may be calculated. If the distance to the star is known, the total radiation from it can be obtained from that falling on the mirror of the telescope, which is the amount measured. Without knowing the distance to the star, however, its angular diameter can be obtained.

The angular diameters of some of the largest stars have been measured directly with the stellar interferometer. The values obtained from heat measures, while in most cases somewhat larger than those obtained with the interferometer, are of the same order of size. They tell us, for example, that the

star Sirius, although much hotter and closer to us, is so small that the total heat from it is about equal to that from the big star Betelgeuse, which is over thirty times as far away. The diameter of Sirius is one and a half times the diameter of the Sun, while the diameter of Betelgeuse is more than two hundred times that of the Sun.

Dr. Pettit and Dr. Nicholson have also used the vacuum thermocouple, attached to the 100-inch telescope, to measure the temperatures of the planets and still more recently the temperatures of various regions of the moon.

Our knowledge of such temperatures, as well as of the temperatures of the stars, comes from study of the amount and quality of the radiation which reaches us from them. The Moon and the other planets, of course, are much cooler than the stars; consequently the light that we see when we look at them is reflected sunlight. They, however, also radiate energy-waves of lengths too long to be visible to the human eye. This part of the radiation is called planetary heat.

Separating Radiation

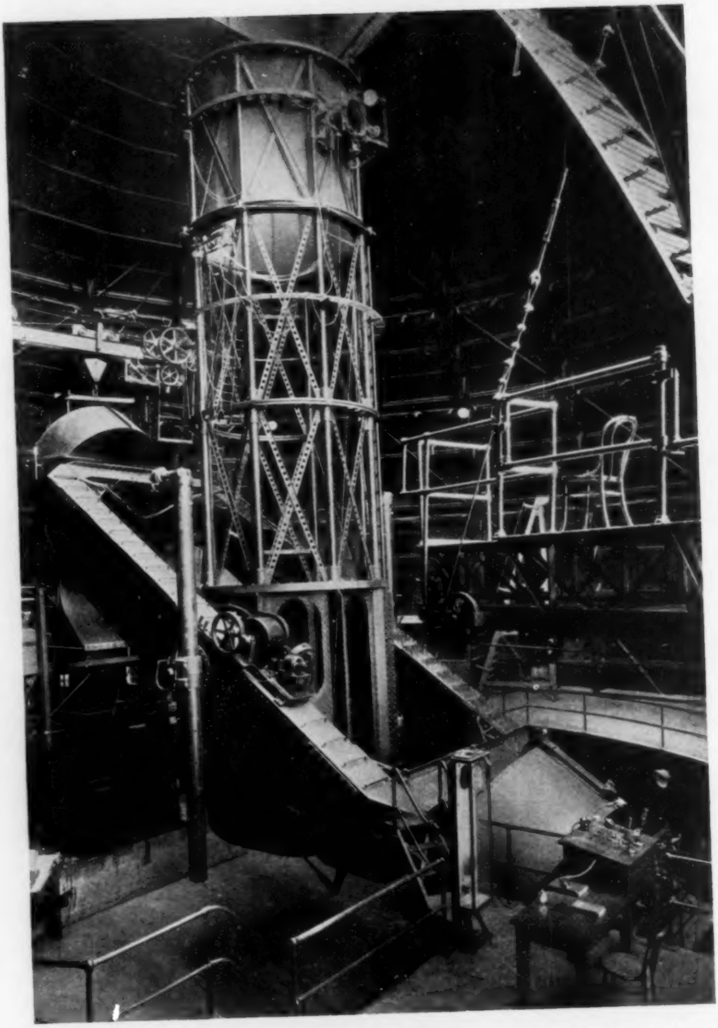
Planetary heat cannot pass through glass for the wave-lengths are too long whereas reflected sun-light can. It is therefore easy to separate the one from the other by placing a thin glass screen in the path of the radiation.

In practice the planet to be studied is first observed without any glass in the optical path of the telescope. The thermocouple is then heated by all the heat from the planet, planetary heat and reflected-sun heat, most of the latter being visual light. Next, a thin piece of glass is placed in the optical path of the telescope. This absorbs all the planetary heat, but transmits the reflected solar radiation. Inasmuch as the distance of the planet and the area of the surface which is sending heat to the thermocouple is known, the temperature can be calculated from the amount of radiation which is sent us per unit area.

The most uncertain part of the calculation lies in the correction which must be made for losses when the rays are passing through the Earth's atmosphere. Atmospheric conditions on the planets are so different from those on the Earth that the actual temperatures such as would be read if a thermometer were placed near their surfaces might differ greatly from those obtained by radiation methods.

Planetary Temperatures

Mercury is certainly very hot and has little if any atmosphere. The maximum temperature is about 700 degrees C absolute (800 degrees F). The distribution of radiation over its surface is much like that of the Moon.



Showing the 100-inch telescope and its thermocouple attachment (near the top) for measuring the heat radiated by stars and planets. With this instrument Dr. Pettit and Dr. Nicholson of the staff of Mount Wilson Observatory of Carnegie Institution of Washington have found that the surface temperatures of stars range from 41,000° Fahrenheit, for the very blue stars, through 10,000° for those of the class to which our Sun belongs, to 2,800° for the very red, long-period, variable stars.

Venus is covered with clouds and the radiation measured is from the high cloud surfaces and tells very little except by inference about the actual surface temperatures. The night temperature at this high altitude in the atmosphere of Venus is much greater than that on the surface of Mercury or the Moon, being about 250 degrees C absolute (—9 degrees F).

The temperature on Mars varies greatly with the season and the time of day, but the temperatures there are somewhat like those on the Earth, at least like those at very high elevation where the atmosphere is rare.

The outer planets are very cold, as might be presumed from their great distances from the Sun, unless they give off heat from their interiors.

Not many years ago it was commonly supposed that Jupiter was warm, probably warm enough to give out some light of its own. The thermocouple, however, shows that this is not the case, and that the temperature of Jupiter is about 135 degrees C absolute (—216 degrees F).

Temperature on the Moon

The absolute temperature of a theoretically "perfect radiator" varies as the fourth root of the total radiation emitted by it from a unit area of its surface. The Moon, strictly speaking, does not behave as an ideal radiator would; but for practical purposes it may be regarded as such. The measurements of the total lunar radiation therefore lead directly to estimates of the Moon's temperature.

From numerous observations made by Dr. Pettit and Dr. Nicholson during the last seven years the temperature at the point on the Moon where the Sun is directly overhead has been found to be 118 degrees C (244 degrees F) at the time of full Moon and 65 degrees C (149 degrees F) at first and third quarters. The difference in these results apparently is caused by the roughness of the surface, which increases the radiation sent out in the direction of the lunar zenith and decreases that emitted toward the horizon. The true temperature lies between the figures given.

Measurements made on the dark side of the Moon gave —153 degrees C (—243 degrees F) for its approximate temperature. An accurate determination for this part of the Moon will, however, require extensive observations, for the lowest temperature which can be detected with the instruments used (approximately —170 degrees C or —274 degrees F) is not much below that indicated by the observations thus far made.

Effect of Atmosphere

The variation in the radiation, and hence in the temperature, over the sun-lit side of the full Moon was obtained by allowing the image of the full

Moon to drift across the receiver of the thermocouple while a moving photographic plate traced the resulting galvanometer deflections. The planetary heat varies from a practically unmeasurable quantity at the edge to a maximum at the center. The accompanying illustration shows the lines of equal temperature upon a relief map of the Moon computed from these data. They represent mean values and do not distinguish between the light and dark areas, called maria (seas) because they were once thought to be bodies of water, in general, are somewhat warmer than the mountainous regions; but the difference is only a few degrees.

The changes in temperature which take place during a lunar eclipse were investigated at the eclipse of June 14, 1927. For the point measured, the temperature fell from 69 degrees C (156 degrees F) to —98 degrees C (—144 degrees F) during the first partial phase, continued to drop to —117 degrees C (—179 degrees F) during totality, and during the last partial phase rose abruptly nearly to the original temperature. The enormous fall in temperature of 186 degrees C (335 degrees F) observed during this eclipse, the greater part of which took place during the partial phase, is in strong contrast to the fall of 2 degrees or 3 degrees C (4 degrees or 5 degrees F) observed at solar eclipses on the Earth.

This illustrates the governing effect of an atmosphere on planetary temperatures, since the only physical distinction between the factors involved in this comparison is the absence of an atmosphere in the case of the Moon and its presence in the case of the Earth.

It happens that the radiation from the Sun runs to shorter wave-lengths than the radiation from the Earth. It happens, also, that short waves go through our atmosphere more easily than long waves do. This is because of the presence in the atmosphere of carbon dioxide and of water vapor, both of which serve to differentiate wave-lengths. So our atmosphere acts as a sort of trap for heat-rays, letting in easily those from the Sun and holding back those from the Earth. Thus the excessive cooling which, otherwise, would take place at night is prevented.

Committee on Study of Moon

There is much more to be learned about the planets and the Moon from thermocouple measures. It is quite probable that the observed rates of cooling and heating of the Moon, as the amount of sunlight which falls upon it varies, may lead to very definite knowledge of the character of the rocks of which its surface is composed. In fact laboratory study has already been made upon various earth materials—granite, lava, quartz-sand, and pumice, among others—heating and cooling them, observing the rates at which their

temperatures change, and comparing the results with the rate of change which takes place on parts of the Moon's surface as shown by the thermocouple.

In 1925, upon recommendation of President Merriam of Carnegie Institution, the Executive Committee created a committee known as the *Committee on the Physical Features of the Moon* and appointed to it a group of scientists to act under the chairmanship of Dr. Fred E. Wright of the Geophysical Laboratory of Carnegie Institution.

In attacking the problems presented by the surface features of the Moon, the committee is seeking to ascertain the nature of the materials exposed at its surface and their behavior under lunar surface conditions. When this information is at hand the committee expects to proceed to the classification of the surface features and to the analysis of the several hypotheses which scientists have advanced to account for them.

The Use of a Motorized Project in Demonstrating Simple Mechanical Facts

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The class was just concluding an activity featuring the study of oil production in Southern California. All of the usual things had been done—field trips, charts, models, outside reading, written and oral reports, etc.—when a bright but rather visionary student who had just put the finishing touches on a miniature oil derrick, suggested that we hook up the model with some sort of motive power other than hand power.

An informal discussion followed, during which various types of motive power were considered. One pupil wanted to bring a toy steam engine, another offered to bring a small electric motor. But after studying the various advantages and disadvantages of each device, we finally decided that a spring motor would be the most practical for the operation of the model derrick.

A spring motor was salvaged from an old discarded talking machine. The boys constructed a base for the motor and attempted to hook the drive shaft to the model. Here the group ran into difficulty, for the connection was too rigid to permit smooth operation.

During this time the class took up the general question of power "hook-ups" and found that power could be transmitted in various ways, by means of belts, gears, gears and chains, and by direct drive. The merits of each type were briefly dealt with in a short, directed discussion. One member of the group gave a report on the use of power "hook-ups" in industry.

The model still ran in a rather jerky and spasmodic fashion. The group was quite perturbed about this unsatisfactory operation, so they complained about it and at the same time asked for a remedy. They were told that they would have to solve the problem in the same manner as it would be solved in industry. They were rather at sea at first, but after making inquiries and consulting references, they found that a flywheel would be the answer to their problem. The wheel was cut out of a solid piece of wood and to the great satisfaction of the pupils it worked satisfactorily when assembled.

This particular phase of the motorized project proved to be the most instructive feature of the entire experiment, for the group had worked out a practical demonstration of a law of inertia that is applicable to practically all machines. The interest created was far-reaching and gave significance to

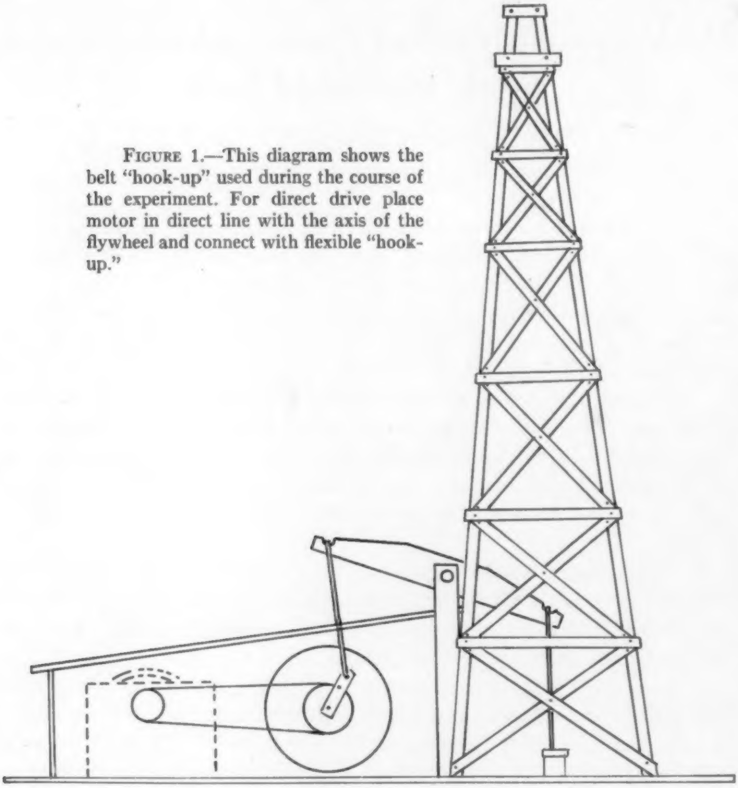

FIGURE 1.—This diagram shows the belt "hook-up" used during the course of the experiment. For direct drive place motor in direct line with the axis of the flywheel and connect with flexible "hook-up."

matters of every-day mechanical experience. One pupil told of the large fly wheels used in his father's pumping plant, another told of his older brother balancing the flywheel in his Ford automobile in order to get greater speed. Still others took advantage of the knowledge gained to improve their mechanical toys by adding flywheels.

After explaining the function and operation of the governor on the spring motor and performing simple experiments with gears to illustrate the relationship between speed and power, the boys were left to themselves.

Entirely unaided they went about the task of reducing the friction, bettering the alignment, and perfecting the balance of the working parts of their model derrick until they were able to operate the model for twenty-five minutes without rewinding it.

Research Studies Related to the Teaching of Science*

CHARLES J. PIEPER
New York University

8. Methods of Teaching Science

a. *General Studies*

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* Continued from the October and December issues.

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What Is Professionalized Subject-Matter in Teacher-Training?

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In the attempt to "professionalize" subject-matter courses in teacher-training institutions, clear concepts of the meaning of the term are needful in order to make better applications of the purpose underlying the introduction of the term. With the rapid additions to knowledge in every field of science, it is becoming more and more necessary to make careful selections of content for the courses in our schools, dependent upon the function of such chosen content in the courses in which it is used. Teacher-training courses are intended to prepare teachers for teaching, and it is logical to think that they must be different in content and method from similarly named courses in engineering or medical schools, for example. Professor Bagley has aptly made this term stand out in educational thought. An additional step is to discover how it may be applied in courses in science.

This article is a summary or a synthesis of replies to a questionnaire originating in a committee appointed by the National Association for Research in Science Teaching to make some studies of teacher-training for teachers of science. A tabular summary is given in Appendix III but a synthetic conception as represented by the questionnaire replies is thought a more acceptable means of comment. The questionnaire was sent to 200 faculty members closely identified with the training of science teachers in (1) colleges and universities having departments of education, (2) teachers colleges, (3) state normal schools, and (4) city public normal schools. This summary is based upon 84 replies received by October 28, 1931.

The general query in the questionnaire reads as follows: "In what particulars will a teachers' professionalized course in biology, physics, chemistry, or other natural science be different from a conventional subject matter course for a liberal arts college?" Fifty-two designations were given, with a space reserved for additional contributed designations and remarks. While a few of the original statements were found to be ambiguous, most of them were meaningful enough to aid in crystallizing thought or stimulating further thinking.

According to the consensus of those who returned the questionnaire, a professionalized subject matter course will have the following character-

istics which help to differentiate it from the conventional liberal arts college course:

1. It will not be simpler in content but it will clearly distinguish *consumer*[1] and *producer* science and emphasize the former. In other words, content selection will be consumer science primarily.

2. The methods of the professionalized course will be possible of imitation by the future teachers in training but the content will be on a higher level of difficulty and include more technical material than lower school courses.

3. There will be ample illustrative directed study, supervised study, and informal discussion, with particular emphasis on methods to be used in study.

4. It will emphasize the functional aspects of science and its relations to social and community life; will disclose and encourage enjoying and satisfying avocational activities; and will direct attention to related vocational possibilities and health phases. (These may be considered as broad objectives.)

5. It will attempt to produce *specific* habits, skills, and attitudes, and demand mastery of specific and definite knowledge. (Minimum essentials.)

6. It will include considerable biographical and historical material but will stress selection and adaptation of content to individual life needs.

7. It will stimulate and provide time for individual projects and will not be so crowded in requirements that no time is reserved for student recreation to eliminate possibly injurious fatigue. (Projects are understood to be any purposeful, chosen activity.)

8. It will concentrate attention on selected instructional units and not attempt to cover the whole logically developed field of the subject. These units may well constitute the minimum essential portion of the organized minimum essential and project program.

9. It will direct attention to relative values of various portions of the content and particularly develop the larger or major concepts. The use of content will be adapted to student ability.

10. It will not attempt to train teachers to have encyclopedic knowledge of the whole logically developed subject but will be extensive rather than too detailed and technical.

11. The fluidity of knowledge will be emphasized. In other words, knowledge is not fixed and final but is continually changing.

12. Vocabulary difficulties will receive studied attention; subject difficulties shall not be those of higher mathematics; and subject treatment will be predominantly concrete.

13. The utilitarian values of knowledge will be stressed and utilitarian knowledge will be largely selected.

14. Various phases of achievement will be measured including knowledge, appreciations, techniques, and skills.

15. Methods and subject matter will be taught concomitantly and not in separate courses.

16. Instructors will be looked upon as student advisors to self-activity, and emphasis will be placed upon positive aspects of attainment. (Rewards rather than punishment.)

APPENDIX I

Statements Added to the List of Designations by Those Responding to the Questionnaire

Statement	Frequency
1. The professional course should illustrate proper teaching	6
2. Develop independence of thought and judgment, and resourcefulness	5
3. Study of laboratory equipment and ordering supplies	4
4. Good demonstrations with apparatus	3
5. Should be inspirational and develop enthusiasm	3
6. Bibliographies and ordering books	2
7. It will be dominated by science concepts and their applications	2
8. Stress the value of teacher personality and character	2
9. The instructor should have typical teaching experience	2
10. Writing up current happenings in proper style	1
11. The content will represent a history of science	1
12. It will furnish an overview of science	1
13. More extensive and intensive treatment than secondary school science	1
14. Professionalization is largely organization of study units	1
15. A synthetic study of objectives of science	1
16. Emphasize vocational outlets	1
17. Emphasize the essential unity of "what" and "how" in teaching	1
18. Emphasize psychological rather than logical	1
19. Use the laboratory experiment as the basis of the course	1
20. Instructors should be academic and educational scholars	1
21. Liberal, not specialized education	1
22. Must not degenerate into a course in details of method	1
23. Large understandings and broad vision of science	1
24. Emphasize the methods of science	1
25. Emphasize the relation of science to other subjects of study	1

APPENDIX II

The Questionnaire Used in This Study

DEAR FELLOW-TEACHER: This questionnaire is being circulated to a relatively small number of experts as a part of a study of training for science teachers which is being sponsored by the National Society for Research in Science Teaching. We know the objections to questionnaires, but know no other way to learn your ideas on these topics. I am presuming on your good nature to make responses and return at your earliest convenience.

Faithfully yours,

(Signed) ARCHER W. HURD
Research Associate

The term *professionalized subject matter* is being used at the present time, especially in connection with teacher-training courses. We wish to establish some clear and definite concepts which the term *professionalized subject matter* may typify. Will you express your judgment of each item by a yes (Y) or no (N) placed in the blank at the right of each. The points will be more clear if in each case your comment expresses *in what particulars a teacher's professionalized course in biology, physics, chemistry, or other natural science will be different from a conventional subject matter course for a liberal arts college.*

1. The professionalized course will include simpler content. ....
2. It will distinguish between *consumer* and *producer* science. ....
3. It will primarily emphasize science for the *consumer*. ....
4. The methods of the professional course will be possible for imitation by teachers of science in lower schools. ....
5. The professional science course will be taught as though to the pupils who are eventually to be taught by the teachers in training. ....
6. The professional course will omit technical material not comprehensible to pupils whom the teachers in training will teach. ....
7. Science in the professionalized course will be on the difficulty level of pupils to be taught by the teachers in training. ....
8. The professionalized course will continuously emphasize details of assignment. ....
9. It will continuously emphasize methods to be used in study ....
10. It will provide illustrative directed study. ....
11. It will provide some illustrative supervised study. ....
12. It will provide illustrative informal discussion. ....
13. It will emphasize functional importance of the facts of science to people. ....
14. It will emphasize the relation of science to social and community life. ....
15. It will particularly disclose enjoyable and satisfying avocational activities. ....
16. It will particularly direct attention to related vocational possibilities. ....
17. It will particularly direct attention to health phases. ....
18. It will attempt to produce definite specific habits. ....
19. It will attempt to produce definite specific skills. ....
20. It will attempt to produce definite specific attitudes. ....
21. It will include considerable biographical and historical material. ....
22. It will stimulate and give time for individual project work. ....
23. It will demand mastery of specific and definite knowledge. ....
24. It will treat attitudes, habits, and skills as concomitants. ....
25. It will stress selection and adaptation of content to individual life needs. ....
26. It will make specific provisions for recreational time. ....
27. It will make specific provision for elimination of injurious fatigue. ....
28. It will cover the whole logically developed field of the subject. ....
29. It will concentrate on a few definitely planned teaching units. ....
30. It will organize a minimum essential-project program. ....
31. It will recognize as projects all life activities. ....
32. It will follow closely the textbook used. ....
33. It will develop specifically large concepts of the science. ....
34. It will direct specific attention to relative values of various parts of the content. ....
35. It will specifically consider adaptation of content to various pupil ability levels. ....
36. It will train all teachers to have encyclopedic knowledge of the whole subject. ....
37. Subject matter should be extensive rather than detailed and technical. ....

38. The instructor should have the research rather than the authoritative attitude toward science. ....
39. Vocabulary difficulties should receive studied attention in professionalized courses. ....
40. Difficulties of higher mathematics should be avoided. ....
41. Subject treatment should be predominantly concrete. ....
42. Emphasis should be clearly on knowledge for life uses rather than for the sake of knowledge. ....
43. All activities should be planned with studied consideration of the factor of *time to be used*. ....
44. Attempts should be made to measure knowledge gained by students. ....
45. Attempts should be made to measure appreciations gained. ....
46. Attempts should be made to measure techniques gained. ....
47. Attempts should be made to measure skills gained. ....
48. The incompleteness of knowledge should be emphasized. ....
49. Methods and subject matter should go "hand in hand". ....
50. Methods courses should follow subject matter courses. ....
51. The teacher should be emphasized as an advisor to pupil self-activity. ....
52. Emphasis should be placed on the positive rather than negative aspects of pupil attainment. ....

Add others to show desirable characteristics of professionalized courses:

53. ....

54. ....

55. ....

56. ....

Remarks:

APPENDIX III

TABULAR SUMMARY OF RESPONSES TO QUESTIONNAIRE ITEMS ON PROFESSIONALIZED SUBJECT MATTER IN SCIENCE*

	Responses				Responses		
Item	Yes	No	Misc.†	Item	Yes	No	Misc.†
1	27	48	9	31	39	27	18
2	58	21	5	32	15	64	5
3	49	25	10	33	75	5	4
4	65	9	10	34	77	3	4
5	34	39	11	35	75	9	0
6	18	66	0	36	8	70	6
7	16	65	3	37	71	4	9
8	37	43	4	38	65	14	5
9	62	21	1	39	75	5	4
10	78	6	0	40	61	13	10
11	77	5	2	41	67	14	3
12	80	2	2	42	73	5	6
13	81	3	0	43	67	10	7
14	83	1	0	44	77	5	2
15	74	8	2	45	76	4	4
16	71	12	1	46	74	4	6
17	72	10	2	47	74	5	5
18	65	14	5	48	72	5	7
19	65	13	6	49	69	11	4
20	73	7	4	50	38	37	9
21	70	8	6	51	77	4	3
22	70	5	9	52	79	1	4
23	79	3	2				
24	56	20	8				
25	74	5	5				
26	47	29	8				
27	46	22	16				
28	35	42	7				
29	45	32	7				
30	45	31	8				

* For items, see appended questionnaire.

† Miscellaneous means "No answer" or "Other answers than 'Yes' or 'No'."

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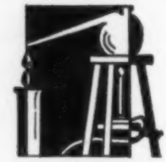
Abstracts 

General Education

SYMPOSIUM. "Proceedings of the First Annual Teacher-Training Conference Held at the Indiana State Teachers' College." *The Teachers' College Journal* 3:1-100; September, 1931.

This volume of the Teachers' College Journal gives a résumé of the Teacher-Training Conference held at Indiana State Teachers' College last spring. Several noted educational leaders participated in the conference. The following problems were discussed: (1) What should be done concerning the guidance of prospective teachers? (2) What should be the institutional policies of teacher-training institutions and how should these be met? (3) What are the public relations problems of teacher-training institutions and how should these be met? (4) How can we help with the student problems in teacher-training institutions? (5) What principles should govern teacher-training curricula? and (6) What should we teach prospective teachers? —C.M.P.

BECKER, CARL H. "Secondary Education and Teacher Training in Germany." *Teachers College Record* 33:26-44; October, 1931.

This is the first of a series of three lectures delivered at Teachers College in November, 1930, relating to education in Germany. In this article the author describes the present educational situation in Germany. According to the author the political revolution which followed the world war wrought great changes in the secondary education and teacher training program of Germany. In pre-war times German education was fashioned and directed by the class or caste system of the old régime. A dualism which could seldom be bridged existed between elementary and higher education. The German people were divided into two cultural groups. This dualism has been eliminated in the present educational system. The newer education is characterized by its emphasis on the importance of spiritual forces and emotions, and the fusing of individual views and aims into a common social ideal. Music, art, sports and physical education are assuming an ever-increasing importance. —C.M.P.

ANTZ, E. LOUISE, "The Philosophers Recommended to Teachers." *Peabody Journal of Education* 9:80; September, 1931.

Of general interest to teachers attempting a revaluation of personal philosophies of education. —R.K.W.

"Report of the Fourteenth Meeting of the American Council on Education." *The Educational Record.* July, 1931.

This whole issue is taken up with the report of the fourteenth meeting which was concerned with problems of school finance. —R.K.W.

ELLIOTT, W. A., "This Workbook Craze." *School Executives Magazine.* 51:19-20; September, 1931.

Chiefly in defense of the workbooks. Contains an interesting analysis of possible uses and values of workbooks as educational tools. Points out no deficiencies of workbooks as tools. —R.K.W.

BROWNELL, S. M. "Shall the Plans for the New School Include Radio Installation." *The Nations Schools* 8:53-58; October, 1931.

This article raises many pertinent ques-

tions concerning the possible uses of radio in schools. It suggests radio installation for all rooms in the school building with central control in the principal's office. A public address system for the auditorium is recommended. There is also a report of a survey of the opinions of 25 administrators concerning the value and uses of radio installations. Most of these opinions were favorable to radio installations. Education in the selection of what is valuable from available broadcast programs. —R.K.W.

GATES, C. RAY. "What Teachers Buy in Life Insurance." *School Executives Magazine* 51: 127-128; November, 1931.

This article contains a suggestive and sane treatment of the problem of life insurance and provision for old age of school teachers. —R.K.W.

JOHNSON, W. P. "Problems Affecting the Publishing Business and the Teaching Profession." *School Executives Magazine* 51:56-57; October, 1931.

This is a frank discussion of the relations of the publishers and members of the teaching profession. The article deals in part with the ethics and economy of duplicating published text, workbook, and test materials by the teacher. —R.K.W.

GILES, J. T. "An Outline of Instructional Problems in the High School." *The High School Quarterly* 20:33-35; October, 1931.

Problems of instruction may be classified under (1) objectives; (2) curriculum; (3) classroom activities; and (4) measurement. Pertinent questions are asked by the author concerning each of these problems. —C.M.P.

Science Education in General

CRUDUP, JOSIAH, "The Science Teacher and World Peace." *Peabody Journal of Education* 9:124-125; September 1931.

A very general notion of the possible service that science teachers may render in the emotional stimulation of their pupils to make scientific achievements contribute to peace. Is this a function of the science teacher? —R.K.W.

GRAY, H. A. and BRUNSTETTER, M. R., "Research in the Field of Educational Talking Pictures." *School Executives Magazine* 51:6-8; September, 1931.

This article contains a useful set of tentative standards for judging the educational values of talking pictures made for instructional purposes. —R.K.W.

CARRIER, WM. H. "Standards of Heating and Ventilation." *School Executives Magazine* 51:58-60, 90; October, 1931.

This article contains scientific data on ventilation compiled by a prominent heating and ventilation engineer. The material should be very valuable for teachers of general science, hygiene, or physics. —R.K.W.

WEBB, HANOR A., "The High School Science Library 1930-31." *Peabody Journal of Education* 9:29-40; July, 1931.

A continuation of Professor Webb's annual review of books suitable for high school science libraries. This list should be in the hands of every high school science teacher. The present list is the seventh of the series. Reprints may be secured from the author at George Peabody College for Teachers at Nashville for 10 cents each. —R.K.W.

HART, CHESTER. "Classroom Equipment for Motion Picture Projection." *The Nation's Schools* 8:98-100; October, 1931.

The author makes practical suggestions on the setting-up of the projector, the nature of screens, darkening the room, convenient outlets, and loudspeaker arrangement, for the ordinary school classroom. —R.K.W.

THYNG, M. MARIE. *"Clubs within a Club —Natural Science."* Education 52:156-159; November, 1931.

The author describes the organization of a natural science club composed of students training to teach in elementary

schools. The major activities of this club are the formation and sponsorship of nature clubs among pupils in the elementary training school. These activities serve as direct preparation for club work in the schools in which the prospective teachers will eventually teach. The author summarizes the qualities for successful club leadership, gives a list of suggested club activities, and offers important suggestions regarding the organization and administration of nature clubs. —F.G.B.

Compton, Arthur H. "What Science Really Is." *Scientific American* 146:32-33; January, 1932.

The "idea of science" may be assigned as the reason that leadership in human progress has passed from the East to the West. To quote the author, "the idea of science is simply an attitude that men may have toward the world. It is a desire to find out how this outside environment, in which they live, works, coupled with a desire to increase their power to control it. It is our attitude that looks at life, determines its methods of operation, and adjusts them, so far as possible, to human needs". All great scientists have had this point of view. The advance of civilization and the hope for its future depend upon science. —C.M.P.

Science in Elementary Schools

"The Child and Science." *Progressive Education* 8:435-540; October, 1931.

The whole of this issue is concerned with elementary and general science teaching; hence it is being reviewed entire.

Several articles serve to focus attention on the function of science teaching for younger children in terms of the fundamental postulates of modern philosophy and psychology applied to the learning process. "Science as Experience and Attitude" by S. R. Slavson (p. 458) discusses the problem solving attitude through science teaching. An article by Frederick Reed, "Gateways to Science" (p. 440) recognizes the great possibilities in elementary science for helping the individual toward a program of enriched living. Another article dealing with the foundations of this problem is "The Humanism of Science" by T. Swann Harding (p. 472). "The Creative Spirit in Science", by Henry W. Paley (p. 494), supports the thesis that science principles should grow out of enriched experience but should not be taught as such to pupils until they have reached a certain maturity. The author considers that organization of science by grades cannot be effected on the basis of principles and generalizations of science.

A fine article by Benjamin C. Gruenberg, "Complacency and Specialization" (p. 443) sets forth the possible advantages that may be attained through the use of the newer methods in practice in the so-called progressive schools, but also some very fruitful discussion of the possible dangers inherent in such methods. Examples cited of improper use of correlation of subjects, undue respect for pupil opinion, etc., are extremely thought-provoking. The article clearly shows the ease with which the values that are thought by many to be inherent in science *as such* may be overlooked while the attention is focused on some other aspect of the teaching problem.

The function of science in developing attitudes of an aesthetic nature is supported by Miss Bertha Stevens in an article "Adventures in Beauty" (p. 449). This article advances the thesis that children have a great ability to sense subtle resemblances of an ethereal and evanescent nature, based on "essential qualities of things more than their external quality." Methods for increasing or making observable the beauties in form of natural objects are suggested, such as the use of the symmetoscope, shadowgraphs, etc. One is reminded somewhat of the mysticism of form and number of Pythagorus.

Two articles deal with the problems of constructing an integrated curriculum. "A Unified Science Program" by F. Martin Brown (p. 479) stresses the need for an integrated program and gives in a rather general form an example of how this is being worked out. "Science in the Integrated Curriculum" by Ellsworth S.

Obourn (p. 487) presents a detailed outline of units for the seventh and eighth grades developed by a faculty committee of the John Burroughs School, St. Louis, in an attempt to merge the various junior-high-school subjects around a central core to which all fields, both academic and artistic, could contribute. The core theme for the seventh grade is "How Man Has Made Nature Serve Him," and was tried out experimentally during 1929-30. The eighth grade units which are centered about the theme "How Nature Serves Man in Modern Civilization" are to be used for a continuation of this experiment during 1931-1932. Much social science material is included. It is hoped that the ninth grade work may eventually be made a part of this plan.

A series of articles describing actual work done at various progressive schools furnishes suggestions to the teacher and is valuable as it represents concrete material which has been successfully used at various age levels. "Preparing the Child for Science" by Lallah Blanpied (p. 501) describes the work done at White Plains, New York, in attempting to develop problem-solving attitudes and ability to apply knowledge in new situations. Two projects, "The Bridge" which involves a comparison of country and city life, and "Household Science of Colonial Days" worked out at the Edgewood School, Greenwich, Connecticut, with children six and seven years of age, are described by Miss Mathilde Koch (p. 506). Other articles describe the work at Bronxville, N.Y., The Park School, Cleveland, and numerous photographs show the work of these and other schools.

—O.E.U. and G.C.S.

TURNEY, AUSTIN H. and TOLLIVER, CRANNEL. "Does Health Instruction Pay." *The Elementary School Journal* 31:460-463; February, 1931.

A report of a study comparing health knowledge of third- and fourth-grade pupils in three schools; a different degree of emphasis being given to health instruction in each case. In addition some evidence was secured bearing on the relation between health knowledge and health. "These data indicate only that health-teaching is effective in increasing health knowledge as measured by this test. They do not show that the increased health knowledge was effective in promoting better health".

—O.E.U. and G.S.C.

THOMPSON, J. L. et al. "The Science Laboratory for Grades Four, Five, and Six in the Coöperative Group Plan." *Educational Method* 10:88-95; November, 1930.

The aims, activities, materials, equipment and floor plan are listed for science in Grades 4, 5, and 6 in the coöperative group plan of instruction. —G.S.C.

WHITTEN, JOHN H. "Science for Fourth Grade." *Chicago Schools Journal* 13: 295-298, 378-381; February, April, 1931.

A course of activities is outlined for fourth grade about the following topics: Insects Injurious to Plants; Indoor Gardening; Trees, Wild Flowers; Cultivated Flowering; Plants; Aquarium Studies; Birds; Mushrooms; Plant Diseases; Weather and Sky; Mechanical Toys and Inventions; Shrubs; Vines; Commercial Woods; Outdoor Gardening. —G.S.C.

WHITTEN, JOHN H. "Science for Fifth Grade." *Chicago School Journal* 13:439-444; May, 1931.

A course of activities is outlined for fifth grade about the following topics: Insects Famous for Their Commercial Products and for Their Social Organizations; Indoor Gardening; Trees; Wild Flowers; Cultivated Flowering Plants; Weeds; Aquarium Studies; Native Fishes; Birds; Mushrooms; Plant Diseases; Weather and Sky; Mechanical Toys and Inventions; Shrubs; Vines; Commercial Woods; Outdoor Gardening. —G.S.C.

WHITTEN, JOHN H. "Science for Sixth Grade." *Chicago Schools Journal* 13:481-485; June, 1931.

A course is outlined for sixth grade in which the activities are arranged about the following topics: Insects; Disease Carriers and Household Pests; Indoor Gardening; Trees; Wild Plants; Cultivated Flowering Plants; Weeds; Aquarium Studies; Birds; Mushrooms; Plant Dis-

eases; Weather and Sky; Mechanical Toys and Inventions; Shrubs; Vines; Commercial Woods; Outdoor Gardening; Soils. —G.S.C.

Science in the Senior High School

Caldwell, Otis W. "School Experimentation." *Teachers College Record* 33: 127-162; November, 1931.

The author discusses the values and types of educational research and briefly summarizes the research studies of the Institute of School Experimentation, Teachers College, Columbia University, during the last ten years. Eighteen studies in secondary school science are briefly described. —C.M.P.

Bayles, Ernest E. "Major Problems in the Teaching of Natural Science." *School Science and Mathematics* 31: 1048-1055; December, 1931.

A plea for the setting of definite objectives in science teaching and definite plans for teaching and testing in terms of the objectives set. —A.W.H.

Mandl, M. M. "The Project Method in High School Biology." *School Science and Mathematics* 31: 1079-1091; December, 1931.

This article contains some helpful suggestions on projects for elementary and advanced classes in biology in public schools. Projects have value in the stimulation of interest and the possible disclosure and development of vocational abilities in pupils. Exhibits of project work will help to stimulate it and will result in definite learning by many pupils. The competitive spirit should be encouraged so as to result in desirable outcomes in completed projects. —A.W.H.

Lynch, Mary E. "High School Biology as a Contributing Factor in Health Education." *School Science and Mathematics* 31:931-951; November, 1931.

The author gives many definite suggestions on how to make biology contribute to the health objective, and shows briefly how it may contribute to other objectives stated in the Seven Cardinal Principles of Education. After health, she stresses the leisure time objective, the vocational objective, and the citizenship objective. The functional values of biology are particularly emphasized, especially in giving useful information and establishing health standards and habits. —A.W.H.

Lillingston, Claude. "Louis Pasteur, A Pioneer of Medicine." *Hygeia* 9:924-927; October, 1931.

The author gives interesting details of a few of the many dramatic incidents in the life of Louis Pasteur. He discusses the demonstration that disproved spontaneous generation; the experimentation that led to the recovery of laboratory animals suffering from hydrophobia and the application of the treatment to the first human patient, the Alsatian boy, who had been bitten by a mad dog; the recovery of sixteen of the nineteen peasants who had been bitten by mad wolves and who had been sent to Paris for treatment; the demonstration of the value of inoculation against anthrax in sheep and cattle; and the various incidents that occurred near the close of Pasteur's life that indicate the love and esteem in which he was held by his followers and by those who came under his influence. —F.G.B.

Howard, L. O. "Which Shall Inherit the Earth—Man or the Insects?" *Scientific American* 145:88-90; August, 1931.

Insects annually destroy one-tenth to one-fifth of all our crops, a money loss that exceeds two billions of dollars. A hundred million dollars is the loss each year in the United States from malaria. Not only do insects eat our crops, but ruin all sorts of stored products—grains, dried fruits, clothing, rugs, furniture, dwellings and so on. Man's invention of agriculture has been a boon to insects. The author points out ways in which insects are better adapted to their environment than man is to his environment. Insects offer a real menace in the battle to determine the ultimate possession of the earth. —C.M.P.

"Symposium: Biology." *Teaching* 2:3-32; October, 1931.

The October number of *Teaching*, published quarterly by the Kansas State Teachers College of Emporia, is devoted to the teaching of biology. The following articles are included: "See Kansas First" by Frank U. G. Agrelius; "Things That Plants and Animals Do" by Lyman C. Wooster; "High School and College Biology" by John Breukelman; "Educational Biology" by Helen Schaefer; and "The Teaching Museum" by John Breukelman. —C.M.P.

GUILD, BRUCE H. "The Need for a More Socialized Emphasis on Chemistry as Taught in the High School." *School Science and Mathematics* 31:1075-1078; December, 1931.

More emphasis should be placed in high school chemistry on the social or functional aspects. Technical details should be made subservient to considerations of the part which chemistry plays in the world of today. The needs of the pupil as a future "every man" rather than as a specialized chemist should be a more important criterion of content selection. —A.W.H.

DUNBAR, R. E. and GRANDY, I. J. "Chemistry Tests Available for Use in High School Classes." *School Science and Mathematics* 31:1100-1102; December, 1931.

A list of chemistry tests with brief descriptions, names of publishers, and costs. A short bibliography on testing is included. —A.W.H.

MOORE, H. K. "The Content of a Unit on the Metallurgy of Iron and Steel for Eighth Grade Problem Boys." *School Science and Mathematics* 31:952-968; November, 1931.

The author outlines a teaching unit designed to interest boys selected as problem cases from other schools. The unit contains experiments, work exercises, informational paragraphs, illustrations, test suggestions, related reference list of books, and simple definitions for difficult words.

—A.W.H.

PERSING, K. M. "The New-Type (Objective) Examinations in High School Chemistry." *Journal of Chemical Education* 8:2227-2237; November, 1931.

The author discusses new-type examinations as to: (1) kinds of examinations; (2) function or use of objective tests; (3) types of objective tests; (4) criteria for judging a test; (5) objective tests in chemistry; (6) test of laboratory technic.

—C.M.P.

CAMPBELL, CARL G. "Evaluating General Chemistry Texts." *Journal of Chemical Education* 8:2404-2407; December, 1931.

The author presents a score card for evaluating the relative merits of chemistry texts. The score card contains 32 items ranked in order of importance. Items selected were evaluated by 133 teachers of chemistry, authors of general chemistry texts, and specialists in science education.

—C.M.P.

COLLIER, ROBERT. "A New Type of Chemistry." *Journal of Chemical Education* 8:2214-2226; November, 1931.

The author, forsaking the regular high-school type of chemistry course, has developed a new type of chemistry course which he is teaching in the South High School of Denver, Colorado. The new course emphasizes the practical aspects of chemistry and at the same time meets the minimum essentials of high-school chemistry as outlined by the Committee on Chemical Education of the American Chemical Society. An outline of each unit together with references and laboratory experiments is included. The introductory unit takes up some of the fundamentals of chemistry such as equation-writing, atomic weights, electron theory, and so on. This unit is followed by units on food, clothing, shelter, health, automobile, radio, and motion-picture. —C.M.P.

CARMICHAEL, PETER A. "Cotton Stalks, A New Source of Rayon." *Scientific American* 145:248-250; October, 1931.

A series of experiments have been carried out at the University of North Carolina which indicate the possible utilization

of the whole cotton plant—bolls, stalks and all—in making rayon. Heretofore the problem of cost has prevented the use of cotton in making any but the finest rayon. The new chemical process seems likely to reduce the cost to about one-twentieth of what it is at present. Should the process prove as successful as preliminary tests show, the cotton industry will be revolutionized and cotton raising put on an entirely new basis. Removal of cotton seed oil from the cotton-pulp is a problem as yet only partially solved in the new process. Cotton picking is unnecessary as the cotton may be mowed by machinery. Experiments are also being made in two methods of planting cotton: drilling (as in wheat) and broadcasting. —C.M.P.

Farwell, H. W. "What Am I Really Doing?" *School and Society* 34:686-691; November 21, 1931.

The author, a well-known physicist of Columbia University, believes that every physics teacher ought to ask himself two questions: "What do I think that I am doing?" and "What am I really doing?" The author believes that it is a mistake for physics teachers to require a particular degree of accuracy before accepting the experimental results from a student's performance of a given laboratory experiment. It is much more important for a student to report exactly what he finds. Too many physics teachers insist on an over-emphasis on precision and arbitrary limits. Although physics cannot be presented without the use of some mathematics, some teachers have so "mathematized" physics, that the course has become a course in applied mathematics rather than experimental science. Contrary to opinions held by some teachers, colleges are not determining the subject matter and kind of laboratory experiments taught in high school physics. Physics teachers need to keep more up to date with happenings in their field.

—C.M.P.

New publications

CHEYNEY, E. G. *What Tree Is That*. New York: D. Appleton and Company, 1930. 189 p. $2.00.

This practical guide to the study of trees is "dedicated to those who know no botany and yet would know the trees." Trees are classified either as evergreens or as hardwoods. Sixteen descriptions appear in the former group and seventy-eight in the latter. The trees described are those usually found in the northeastern part of the United States.

A brief description of each family of trees is given on the right-hand page, together with an account of its principal features, such as bark, fruit, leaf, range and use. On the opposite page is an outline drawing of the leaf, fruit, and other distinguishing features. Technical terms found in many guides to trees have been largely eliminated from this guide. Elementary science teachers and others who have had little or no training in the study of trees will find this guide very useful. By employing this guide a previously untrained teacher should be able to answer a child's question, "What tree is that?"

—C.M.P.

HRDLICKA, ALES, *Children Who Run on All Fours*. New York: McGraw-Hill Book Company, 1931. 418 p. $5.00.

The children that run on all fours may be your children or mine. This book consists primarily of case histories of children who have walked on all fours rather than having crawled on their hands and knees, as do the majority of human infants. The period of running on all fours is limited in most cases to the normal crawling period, beginning at the time when the infant starts to develop some form of locomotion and extending up to the time when he can successfully walk upright in the normal, adult fashion. The children considered are chiefly normal white children taken from cases reported by parents living in this country. Most of the children are clearly normal children, showing no greater tendencies to animal-like behavior, other than the running on all fours, than do other children of the same age. Later case histories are available for many, and these exhibit no later abnormalities.

The author interprets the running on all fours as evidence of the animal ancestry of mankind. It is possible, however, to interpret such material as merely an accumulation of interesting cases of variations in crawling, for it is well known that infants in general have a great number of peculiar variations from the normal crawling means of locomotion. The reader may make his own interpretation. By far the greater part of the book is taken up with letters of parents and others reporting the case histories of the children.

—R.K.W.

HOOTON, EARNEST A., *Up from the Ape*. New York: The Macmillan Company, 1931. 626 p. $5.00.

This book presents a non-technical summary of the story of what is known about man's ancestry. The material is popularly and accurately treated. The author does not hesitate to present his own point of view on moot questions, at the same time presenting the possibility of

other interpretations. There are brilliant flashes of humor unusual for a book on human evolution. The work is intended for the lay reader. Some of the vocabulary is technical but each section is understandable without the necessity of thumbing a glossary of scientific terms. The title is possibly misleading to the uninformed lay reader. There is no claim that living men are ascended from living races of apes. Man's essential animal structure is stressed throughout, however. The evidence is taken from the wide range of fields that have contributed to the knowledge of our own origins.

Teachers of science will find this a valuable summary of the most recent researches in human evolution. For many high-school pupils the reading may be difficult. Selected students of junior or senior rank in high school will read it with enjoyment. The photographic illustrations of apes are decidedly unusual, some of them are works of art.

—R.K.W.

Johnson, John C., *Educational Biology*. New York: The Macmillan Company, 1930. 360 p. $3.00.

This is a textbook in the *American Teachers College Series,* edited by J. A. H. Kieth and W. C. Bagley. It is intended as a basic text to precede other training in the field of education and to furnish background training and information for courses in educational psychology, educational sociology, and philosophy of education. It is recommended as a course for the first year of study in the curricula of four-year teachers' colleges. The contents include the more important materials of a basic course in general biology, with the stress upon human development and relationships. The significance of the material for interpretation of psychology and education in general is stressed throughout. —R.K.W.

Weld, L. D. and Palmer, Frederick. *Textbooks of Modern Physics*. Philadelphia: P. Blakiston's Son and Company, 1930. 751 p. $3.75.

This book contains the essentials of modern physics presented in a scientific manner and yet in language which the student can understand. It was prepared with the idea that the student could master most of the subject matter by reading and so leave the class period free for experimental demonstration and supplementary lectures. Physical concepts rather than mathematical representation of phenomena are emphasized. The wave method rather than the ray method is used in the chapter on light. —W.G.W.

Weed, Henry T. and Rexford, Frank A. *Useful Science*. Philadelphia: John C. Winston Company, 1931. 238 p. $1.08.

This volume represents Book I of a new three-book general science series for the junior-high grades VII, VIII, and IX. The authors cover the following subject-matter topics: "Water," "Air," "Fire," "Trees," "Rocks and Soil," "Foods," "Yeast," "Fungi" and "Bacteria." There are 30 experiments outlined and suggested that many of them be done at home. There is, moreover, no supplementary work outlined to take care of those pupils of greater than average ability. The material is easily within the understanding of seventh-grade pupils and the average pupil can readily cover the entire book. Helpful questions are inserted in the textual material to assist the pupil and to check his understanding of it.

—W.G.W.

Fraser, Chelsea. *The Model Aircraft Builder*. New York: Thos. Y. Crowell Company, 1931. 384 p. $2.50.

No book will please the air-minded boy who is handy with tools more than this. Descriptions are given for making toy gliders, model flying airplanes, and models of historic machines. Besides demonstrations of how to construct the machines, there is a chapter on "Flying as a Job." The author tells of tests, types of pilot licenses, and gives much information of value to the future aviator.

—W.G.W.

Cain, John R. *Principles and Practice of Hygiene*. Philadelphia: P. Blakiston's Son and Company, 1931. 251 p. $1.75.

This is a textbook for college students.

It recognizes the fact that the elementary and secondary schools have increased the amount of hygiene taught in recent years. The subject matter and principles are presented in a logical and scientific manner. The book does not stress applications but gives enough to illustrate the principles, which "deal with the life cycle of the human organism, presented in its several phases as generalizations with regard to the systems of the body, as they continue in life under varying conditions of environment." —W.G.W.

DAVISON and STROMSTEN. *Mammalian Anatomy with Special Reference to the Cat.* Philadelphia: P. Blakiston's Son and Company, 1931. 311 p. $2.50.

This, the fifth edition, was revised by Dr. Frank A. Stromsten of the State University of Iowa. The text is offered for use of pre-medical and pre-dental students and for students majoring in psychology, education, physiology, and physical education who make mammalian anatomy a basic course of study. Those parts of the text dealing with endocrine glands, the reproduction system, and the brain have been enlarged in this edition.

—W.G.W.

CORWIN, WALLING and CORWIN, MAE Johnson. *The Science of Human Living: Hygiene.* San Francisco: Harr Wagner Publishing Company, 1931. 464 p. $1.68.

This volume comprises four main divisions (units), each subdivided into many projects. The units are: "Foods and Health," "Personal Health," "General Health," and "Health in the Home." The book is a hygiene text adapted to grade VII. Good teaching aids to be commended are the introduction of each project with a list of "questions to be answered while studying this project" and the closing of the project with a list of definite "things to do." —W.G.W.

CORWIN, WALLING and CORWIN, MAE JOHNSON. *The Science of Plant and Animal Life:* Biology. San Francisco: Harr Wagner Publishing Company, 1931. 592 p. $1.72.

The units of this text are: "Introduction," "Seed-bearing Plants," "Spore-bearing Plants," "The Animal Kingdom," and "Agronomy." Besides introductory questions and "things to do" there are references for further study. In addition, distributed through the text, 43 experiments are outlined. The material selected is excellent, the diagrams are good, and the treatment well within eighth-grade ability. The science in the main is sound, though it seems unfortunate that the idea is given (pp. 43, 44, 206) that the nucleus of a cell is not a part of the protoplasm. —W.G.W.

CORWIN, WALLING and CORWIN, MAE JOHNSON. *The Science of Discovery and Invention: Physical Science.* San Francisco: Harr Publishing Company, 1931. 735 p. $1.80.

This volume which is intended for grade IX, covers fourteen units: "Introduction," "Glimpses into Chemistry," "Glimpses into Astronomy," "Units of Measure," "Machines and Work," "Heat," "Electricity," "Sound," "Light," "Air," "Water," "Materials and Construction," "Energy, Force and Motion," and "Changes on the Earth." The book is attractive, the type large and easily read, and the illustrations are generally good. Some teachers would like larger diagrams of the telephone instruments to show more clearly the parts described in the text and illustrations showing experiments with applications of a type which would not work well in a class demonstration are questionable (see pp. 20, 235, and 503). But these are minor defects easily remedied and on the whole it is a very good book, covers a good range of topics, and is written in language easily understood. Eighty-three experiments are suggested.

A valid claim by the authors of this junior-high school science series is that there is no overlapping. There is no opportunity for the cyclic method to apply. The authors are to be congratulated upon carrying out their plan in a very successful manner, even though some will doubtless question the advisability of drawing the lines quite so sharply in these grades,

since it appears a step towards putting the special sciences in elementary form down into the junior high school.

—W.G.W.

Northrop, F. S. *Science and First Principles.* New York: The Macmillan Company, 1931. 299 p. $3.00.

As an intellectual movement, science has two aspects or phases: "It moves forward with the aid of exact mathematical formulation to new applications, and backward with the aid of careful logical analysis to first principles." Science teaching in most of our schools builds up a body of information regarding the practical applications of selected working hypotheses that have been useful, and concerns itself little or not at all with first principles, or even later ones. Moreover, the several sciences that have gained recognition among curriculum makers are commonly taught as if they have no relation whatever to one another, or to any of the remoter "disciplines," except perhaps mathematics. It is for these reasons that teachers of the sciences should find this book both informing and stimulating, although it is not one to read casually at odd moments of relaxation: it demands serious work and a fresh mind. And it deserves both.

The six chapters that make up the book contain the material presented originally in a course of lectures at New York University. The subject matter and the bearings of the problems discussed are indicated by the chapter headings: "The Significance of Contemporary Scientific Thought"; "The Theory of Relativity"; "Quantum and Wave Mechanics and Thermo-Dynamics"; "The Living Organism"; "Man"; "The Foundations of Experience and Knowledge." The historical survey of thought from Thomas Aquinas to Heisenberg, and the correlation of scientific and philosophical development must be helpful to every teacher of science. —B.C.G.

Babor, Joseph A., Estabrooke, W. L., and Lehrman, Alexander. *Elements of General Chemistry.* New York: Thomas Y. Crowell and Company, 1931. 601 p. $3.75.

This beginners' college text is particularly for those students who enter college with no high school chemistry background. It has the usual scope. The periodic law and the atomic structures are introduced early in the course. The electron point of view is used in explaining chemical reactions. The principles of chemistry are covered in the first half, the second half being left for applications. The best results are secured by having supplementary lectures, including lantern slides, to show industrial plants and processes which are not illustrated in the text. —W.G.W.

Babor, Joseph A., Estabrooke, W. L., and Lehrman, Alexander. *Laboratory Manual in Elements of General Chemistry.* New York: Thomas Y. Crowell and Company, 1931. 430 pages.

This is a cloth-bound laboratory manual to accompany the text by the same authors. It outlines 153 experiments. The experiments are printed on one side and the other side is left for student's notes.

—W.G.W.

Van Buskirk, Edgar F., Smith, Edith Lillian, and Wilson, James R. *Workbook for the Science of Every Day Life.* Houghton Mifflin Company, 1931. 222 p. $0.72.

The Workbook is so planned that pupils may work on their own responsibility and not require the constant attention of the teacher. The problems follow the textbook. Those problems which are essential to an understanding of the reading matter of the text are marked "Required." Others less important are marked "Optional." A third group are marked "Advance Credit." In this way, work is graded to take care of individual differences in ability. The details of the problems are carefully worked out, and blank spaces are left for pupils' answers. —W.G.W.

Hackh, Ingo, W. D. *Structure Symbols of Organic Compounds.* Philadelphia: P. Blakiston's Son and Company, 1931. 139 pages.

This book gives the fundamental concepts of atomic structure and the advantages of structural symbols. The author claims a larger amount of organic chem-

istry can be covered in a given time by using these since the student can visualize and compare more atomic arrangements than he otherwise could. Apparently this book should be of much help to the student of organic chemistry especially in a study of the recent theories of atomic structure as applied to organic compounds.

—W.G.W.

TIMM, JOHN ARREND. *An Introduction to Chemistry,* New York: McGraw-Hill Book Company, 1930. 561 p. $3.50.

This textbook has been written for "those college students whose major interests lie elsewhere" than in chemistry but who desire an overview of the field of chemistry, its methodology and philosophy. That the author has succeeded fairly well in this purpose of writing a pandemic chemistry may be seen from an examination of the textbook content and its organization.

The author severely takes to task those persons who advocate that no differentiation should be made in the kind of chemistry taught to those who will need a knowledge of chemistry in their profession and those who will not pursue further courses in chemistry. Monotonous presentation of the properties of one element after another, drill in equation writing and problem solving, and the development of a certain degree of mental dexterity in handling the tools of chemistry are decided by the author who believes "they represent a cruel waste of time for the student who is specializing in other fields." Consequently no laboratory work is to accompany the use of this text. While admitting that too much emphasis has been placed upon mere facts in chemistry without attempting to coördinate those facts into general principles, and that time has been and is being wasted in solving problems, writing equations and doing laboratory work, the reviewer does not subscribe to the philosophy that these should be relegated to the pedagogical scrap heap of outworn methodology even in cultural courses in chemistry. A true insight into the scientific method and the philosophy of science can be attained only through the individual use of these tools and not merely by watching another person manipulate them. On the other hand too many science teachers are not using to the extent that they should one of the most effective methods of teaching science, the science demonstration. Apparently the author makes extensive use of this device.

The text embodies subject matter that is used in a course offered at Yale. The style is lucid and attractive and replete with descriptive and illustrative material. It treats chemistry as a series of related phenomena rather than as a host of separate facts. It attempts to give a student some acquaintance with the field of chemistry and in this connection excellent references have been indicated. The book is strictly college level and has not been "written down" to the student. It is rather with certain philosophic assumptions of the author that the reviewer disagrees than with the context of the textbook. The subject matter seems to be excellently selected and arranged. The topics are largely the ones found in conventional textbooks. Theories are developed from an historical point of view. The use of chemistry in the development of natural resources, in solving the problems of industry, and in the daily life of the individual is emphasized.

—C.M.P.

SARTON, GEORGE. *The History of Science and the New Humanism.* New York: Henry Holt and Company, 1931. 178 p. $2.00.

Three lectures given at Brown University in 1930 under the Colver lectureship plan make up this very good book. They are, "The History of Science and the History of Civilization"; "East and West"; and "The New Humanism". The author's purpose is to further the cause of the "New Humanism" in attempting to close up the gap between two "hostile groups,—which we might call for short the literary and the scientific,—who do not speak the same language nor think the same way." The old humanism "was represented by the ultra-literary group and characterized by nothing more clearly than by its strong anti-scientific prejudices." The author's life motif which is emphasized in all three lectures and especially the first, is shown

by his own statements: "My own hero is not the talking man, but the craftsman in his shop, the scientist in his laboratory, doing his best silently. Not the man who talks about beauty but he who creates beautiful things——; not the man who talks about truth but he who helps discover it."

The first lecture tries to show that the history of science is more nearly the real history of civilization than the conventional history we usually read, consisting of accounts of—"soldiers marching to war—the blowing of trumpets and the noise of battle—the king sitting on his golden throne, the regal and holy processions, bishops blessing the multitude" and so on. The real history of mankind is "largely secret" and is wrought in the minds of scientific discoverers.

The second lecture shows that the eastern civilization has contributed priceless gifts to mankind in the form of "creative impulses"; the first from Egypt and Mesopotamia; the second from Israel—; the third from Arabia and Persia." There are four main phases of the history of science; the "empirical development of Egyptian and Mesopotamian knowledge"; the "building of a rational foundation of astounding beauty and strength by the Greeks"; the mediaeval "many centuries of groping—to solve pseudo-problems" precipitated by the conflicts of Greek philosophy and religious dogma; and the final establishment of the experimental method of problem solution, or modern science. The fourth stage, in which we now are, has brought "the most elaborate discipline of thought" ever conceived. "The East was its mother, the West was its father." We must, however, realize that the experimental method cannot be applied to everything, and that it may easily be misapplied.

The third lecture recommends a type of education in which the history of science has a large and significant place. It is worthy of careful consideration although the author is an enthusiast about his own field (the history of science) rather than a professional educator versed in the study of education itself.

The book is very good reading because it is interpretative in a big way. It leaves the casual reader with some very clear conceptions which he would not easily get from a more detailed historical account. It should do much to bridge the gap between the literary and the scientific intellectualists and make each cognizant of the distinct contributions of the other to the "New Humanism". The book should have a wide reading. —A.W.H.

Stochard, Charles R. *The Physical Basis of Personality*. New York: W. W. Norton and Company, Inc., 1931. 320 p. $3.50.

As the title implies, the book attempts to outline the physical basis underlying personality. The author discusses both prenatal and post-natal development and emphasizes particularly the former as a determiner of future physical characteristics and attendant personality traits. To him, various features of pre-natal environment which tend to enhance or inhibit cell development should be given much more stress than is usual. The beginning of personality is at the moment of fusion of male and female germ cells and much of personality is fixed before the time of recognized birth.

While the book is based upon sound knowledge of the laws of inheritance in so far as they are now known, and upon experiments recently conducted by the author and others, the treatment is non-technical enough for the average lay reader. Indeed much of its value resides in its clear statements of the present theories of inheritance. It does not neglect post-natal development, however. There is considerable discussion of the effects of internal glandular secretions in influencing physical form and mental traits.

These discussions lead the author to the conclusion that there are probably two types of physical form, the linear and the lateral, each with a tendency toward certain personality reactions. While this is interesting, the conclusions do not seem to follow logically from the preceding discussion. Undoubtedly mankind may be divided into two classes on the bases of several different contrasting criteria. It seems more logical, however, to regard the

author's evidence as suggesting the possession of all physical characteristics and all personality traits in varying degrees by all individuals. Attempts to pigeon-hole the whole physical and mental personality except in extreme cases seems doomed to failure.

The book is readable, interesting, and well worth reading if its final conclusions are not accepted too hastily. Written by a man grounded in scientific theory and practice, it is far superior to most of the books on similar subjects. —A.W.H.

ROHAN, BEN J. *Exploratory Science, A Means of Life Guidance.* Appleton, Wisconsin: C. C. Nelson Publishing Company, 1931. 259 p.

Believing that each and every individual concerned with the school should be imbued with the philosophy which underlies the institution, the author, in this book, enunciates the philosophy that underlies the junior high school. Convinced that life guidance is an essential duty of the junior high school and that this guidance can best be given through the medium of try-out or exploratory courses, a series of such books have been written in science for use in the Appleton, Wisconsin, Junior High Schools. This book is primarily a teacher's handbook which seeks to give unity and purpose to the several volumes of that series.

Science courses in junior high schools offer an excellent means of life guidance. The author believes that such courses should point out the gifts as well as the dangers of science, survey the various fields of science, emphasize the scientific method of approval in solving life problems, give the pupil a life philosophy based on a social interpretation of natural laws, help the pupil find potentialities within himself, and give incentive, pleasure, and reward through widening vision.

Science teachers will enjoy reading this philosophy of exploratory courses in science for the junior high school. There is a foreword by Elliot R. Downing of University of Chicago and an editor's introduction by Calvin O. Davis of the University of Michigan. —C.M.P.

KILANDER, HOLGER FREDERICK. *Science Education in the Secondary Schools of Sweden.* New York: Bureau of Publications, Teachers College, Columbia University, 1931. 166 p. $1.75.

This is a doctor's dissertation based upon a survey of science teaching in Sweden and comparison of such teaching with that done in the United States. This comparison offers suggestions and recommendations concerning science teaching in this country. The description of the work in the Swedish schools is based upon observations made by the author in visiting the schools and upon data secured from books and reports concerning the work of the schools in Sweden. There is included an extensive bibliography most of which is in Swedish. Chapter divisions are concerned with the historical development of science education; the school organization in Sweden; science education in the secondary schools of Sweden; the professional training of teachers; and reports of committees and investigations in Sweden and the United States.

Science teachers in this country may get a much broadened perspective of their own work by comparing it with progressive work being carried on in European schools. This investigation is to be recommended to teachers for this purpose. —R.K.W.

PRESSEY, SIDNEY L. and PRESSEY, LUELLA COLE. *Introduction to the Use of Standard Tests.* Yonkers, New York: World Book Company, 1931. 265 p.

This rather small volume is intended as a manual for the use of standardized tests. It may be used either by the teacher for his own personal library or for the college teacher offering beginning courses in tests and measurements. Major divisions are concerned with how to use tests, available tests in school subjects and their use, tests of mental ability, and important general principles regarding tests. The first division contains material on the definition of a test and the simple statistical procedures which must be known by teachers in handling tests. Most of the detailed information concerning tests deals with tests in the elementary school. Only one chapter is devoted to high school tests. The

last major division deals with test construction and the testing program. The book is to be recommended to teachers who have not had previous courses in modern testing. —R.K.W.

HUMPHRIES, PAULINE A., and HOSEY, GERTRUDE. *Romance of the Airman.* Boston: Ginn and Company, 1931. 566 p. $1.48.

The book is written as a textbook to be used in junior-high-school classes in English. It is organized under six major topics, and careful selections from the "classics, current literature, biography, autobiography, and history" have been placed under the suitable topics. The six topics are: "The Airman Dreams"; "The Airman Experiments"; "The Airman Invents"; "The Airman Becomes a Pathfinder"; "The Airman Soars to Fame"; and "The Airman Serves." After each selection is given a list of uncommon words or phrases with explanations, an informal test, exercises and topics related to other subjects, and supplementary reading references. At the end of the book is given a chronology of aviation, a glossary, a classified list of related topics, and a bibliography.

This timely book on aviation will be welcomed by many teachers, not only teachers of English, but teachers of other subjects, particularly teachers of science. It is readable, interesting, and well adapted to pupils of junior high school age or older. It is notable because it introduces material of scientific, universal, and current interest into literature classes. Absorbing topics of the day are probably too seldom mentioned in the school and this book attempts to remedy this defect. May other authors follow this excellent example. —A.W.H.

HYLANDER, C. J. *Cruisers of the Air.* New York: The Macmillan Company, 1931. 308 p. $2.50.

In a fascinating manner the author traces the development of the lighter-than-air craft from the flying of the gas-filled balloon made by Montgolfier Brothers in 1783 to the giant zeppelins of today. He presents, step by step, the improvements in the balloon, the non-rigid airships, the semi-rigid dirigible, and the rigid dirigible. He discusses the rigid airship program of the United States and the development of airships for commercial and military purposes. The presentation of contributions made by outstanding experimenters show clearly that the final success experienced by the inventor is the result of facts accumulated through the efforts of numbers of workers.

The book is well illustrated by photographs and line drawings. The preface was written by David S. Ingalls, Assistant Secretary of the Navy for Aeronautics.

"Cruisers of the Air" is a valuable contribution to a field in which literature is not abundant. It will be a valuable addition to the science library of every junior high school. —F.G.B.

MAGOFFIN, R. VAN DEMAN. *The Lure and Lore of Archaeology.* Baltimore: The Williams and Wilkins Company, 1930. 107 p. $1.00.

Here is a little "dollar" book giving a brief account of what archaeology is and what it is for. Part I discusses the lure of archaeology; Part II, the history of archaeology. Part III, the science of archaeology. The book furnishes pleasant reading for one who has considerable acquaintance with ancient history, and is interesting withal to an educated person. It is just long enough to present a clear conception of the work of the archaeologist without being technical in detail. The significance of excavations in disclosing the handiwork of man in ancient times, thereby filling in great gaps of hitherto unknown history, is made clear in a manner which explains why some men have become so enthusiastic in following its lure.

There is opportunity for still less technicality as regards the necessary knowledge of history required. If the writer had assumed less knowledge of ancient history on the reader's part, he would have made the book more widely readable. This is especially true for junior- and senior-high-school pupils. The vocabulary might be simplified for the same reason.—A.W.H.

THOMAS, OSWALD. *Heaven and Earth* New York: W. W. Norton and Company, 1930. 231 p. $2.75.

This book is an attempt, and quite successful, to give conceptions of astronomy to the layman through reading which he will understand and appreciate. It is not statedly planned for any particular school use, but would be of value to pupils in general science classes or college students in courses in orientation or surveys in science. Written by the former chief of Urania Observatory in Vienna, it may be considered as accurate in fact and scholarly in treatment. The style is interesting, and, on the whole, untechnical and non-mathematical. In general, the author explains the common and most advanced conceptions of the structure and operation of the universe. He appeals to the romantic by discussion "An Excursion to the Moon," and "Are Other Planets Inhabited?" Other chapters intriguing to the speculative mind are, "The Birth of Our World" and "Where Does the Universe End?" There are ten chapters in all. It will make a valuable reference book for public and school libraries.—A.W.H.

PISTON, DONALD S. *Meteorology.* Philadelphia: P. Blakiston's Son and Company, 1931. 107 p. $2.50.

In this text the author has used material which gives the student an insight into the physical processes and laws underlying weather and climate. Elementary physical principles are used where needed as a basis for meteorological study. The book will cover one semester in college and may well be included in courses for aviators. It also makes a desirable study in teacher-training institutions, which prepare high school science teachers. There are 89 diagrams, many tables, and a list of 65 problems at the end of the book. —W.G.W.

COMSTOCK, ANN BOTSFORD. *Handbook of Nature-Study.* Ithaca, N.Y.: Comstock Publishing Company, 1931. 932 p. $5.00.

This is the twenty-second edition of Mrs. Comstock's long familiar handbook. It presents a most useful compendium of factual information about plants, animals, minerals and the sky, organized as follows: Part II. Animal Life—1. Bird Study, 2. Fish Study, 3. Batrachian Study, 4. Reptile Study, 5. Mammal Study, 6. Insect Study, 7. Other Invertebrate Study; Part III. Plant Life—1. Wild-flower Study, 2. Cultivated-Plant Study, 3. Flowerless-plant Study, 4. Tree Study; Part IV. Earth and Sky.

The first part of the Handbook presents principles, aims, and methods of nature-study. There is a dualism drawn between nature-study and elementary science which does not present all the possibilities. The picture of elementary science which is painted as opposite to that of nature-study is not the sort of science which can be supported by any educational philosophy. This dualism is probably not inherent in the nature of the subject matter and no doubt a third method of attack could be formulated which would blend the best qualities of nature-study teaching with the best qualities of the programs of those teachers of elementary science who believe that something more is needed than that ". . . the work begins with any plant or creature which chances to interest the pupil." —O.E.U. and G.S.C.

News and announcements

The American Museum of Natural History and the School of Education, New York University, have recently announced five courses for teachers to be recognized for thirty hours credit by the Board of Education of the City of New York and for two points residence credit by the School of Education of New York University. These courses are offered under the joint auspices of the two institutions.

Three of these courses sponsored by the Department of Science of the School of Education New York University are:

Visual Aids in Science Teaching, Associate Professor Charles J. Pieper, New York University.

Earth Features and Their History, Mr. Sydney E. Helprin, Assistant Curator of Geology, American Museum of Natural History.

Astronomical Bodies and Their Movements, Dr. Clyde Fisher, Curator of Astronomy, American Museum of Natural History.

Dr. Frank Lutz, Curator of Entomology of the American Museum of Natural History will be a member of the staff of Cornell University next summer in connection with the course Teaching of Natural History in the Field. He will work with Dr. E. Laurence Palmer and will take the place occupied last summer session by Dr. Clyde Fisher of the American Museum.

The course is limited to twenty students. Each week-end is spent in the field. Students and instructors camp over night. A different site is chosen for each camping trip.

In the Pittsburgh, Pennsylvania, Schools there are now five chemistry periods per week, averaging approximately fifty minutes each. Dr. Harry E. Gill and Charles H. Korns, comprise a committee to prepare a laboratory manual for use only in the Pittsburgh Schools under these conditions. Substitute teachers relieve these men of a limited amount of their classroom duties to give them an opportunity to prepare the manual with care. It will be ready for the printer by May, 1932.

With the appearance of the finished report of the Curriculum Committee of the Secondary Education Board in January, 1932, Mr. Homer W. LeSourd of Milton Academy closed his work as secretary of the committee and as chairman of the special committee on natural science. For ten years Mr. LeSourd has served as a member of the committee which prepared the physics paper for the College Entrance Examination Board. He says "Membership on this committee is obviously not calculated to increase one's popularity among teachers and students of secondary school physics."

At the New Orleans meeting of the American Nature Study Society, held during the Christmas holidays, Dr. E. Laurence Palmer of Cornell University, was elected as the representative of the American Nature Society on the Council of the American Association for the Advancement of Science.

The three normal schools maintained by the City of New York, have recently adopted a new curriculum for the train-

ing of teachers for elementary schools. The course is extended to four years and includes the granting of a baccalaureate degree approved by the Board of Regents of New York State. A significant feature of the new course is the attention given in the first two years to fields of study which are essentially cultural. These "liberal arts" studies are professionalized in the sense that they relate the work of the prospective teacher to important fields of human thought and activity. One such study is a course in Science Foundations of Education, required of all freshman students. The name officially adopted for the new colleges are: The New York Teacher Training College, The Maxwell Teacher Training College, and The Jamaica Teacher Training College.

In the Pittsburgh, Pennsylvania Schools beginning with the second semester of 1931-1932, an experiment will be carried on to determine the value of motion pictures in the teaching of geography as compared with the use of textbooks exclusively.

At a meeting of the Science Section of the Pennsylvania State Education Association, Mr. P. M. Dysart, Schenley High School, Pittsburgh, Pennsylvania, demonstrated Useful Phases of the Oscillography to a large and interested audience.

Miss Rose Wyler has been appointed supervisor of Elementary Science in the Public Schools of Glens Falls, New York.

Dr. George E. Nelson, Assistant Librarian of the College of the City of New York who has recently published his new book entitled The Introductory Biological Sciences in the Liberal Arts Colleges is giving a series of radio talks from Station WNYC, New York City, every Thursday evening from 7:35 to 7:55 on Science and Science Books. The subjects of his talks are similar to the titles of the science book lists prepared by the American Association for the Advancement of Science and described in Editorial Notes and Comments of this issue. The subjects of his discussions for the month of February are: February 11, Science in the World Today; February 18, Exploring for Science; February 25, History of Science; March 3, Biology—the Science of Life.

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